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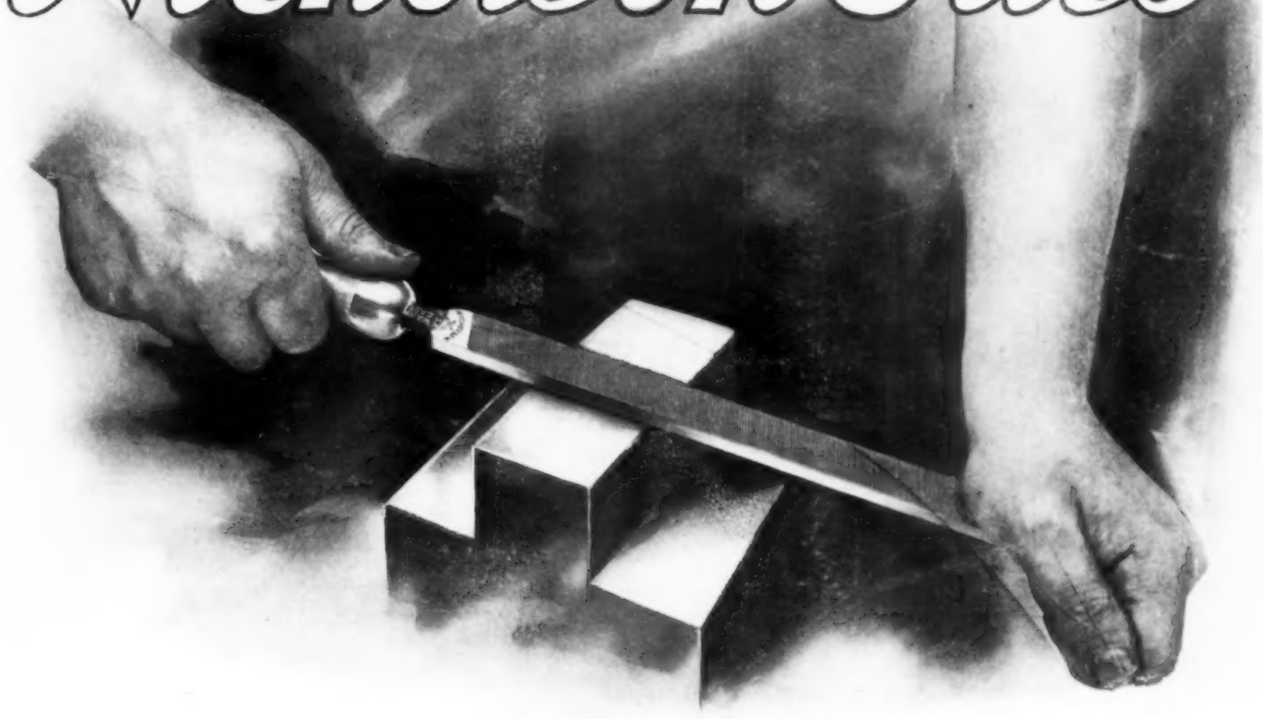
Nicholson Files



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Providence, R. I., U. S. A.

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that increase output and promote convenience in installing, operating and maintaining

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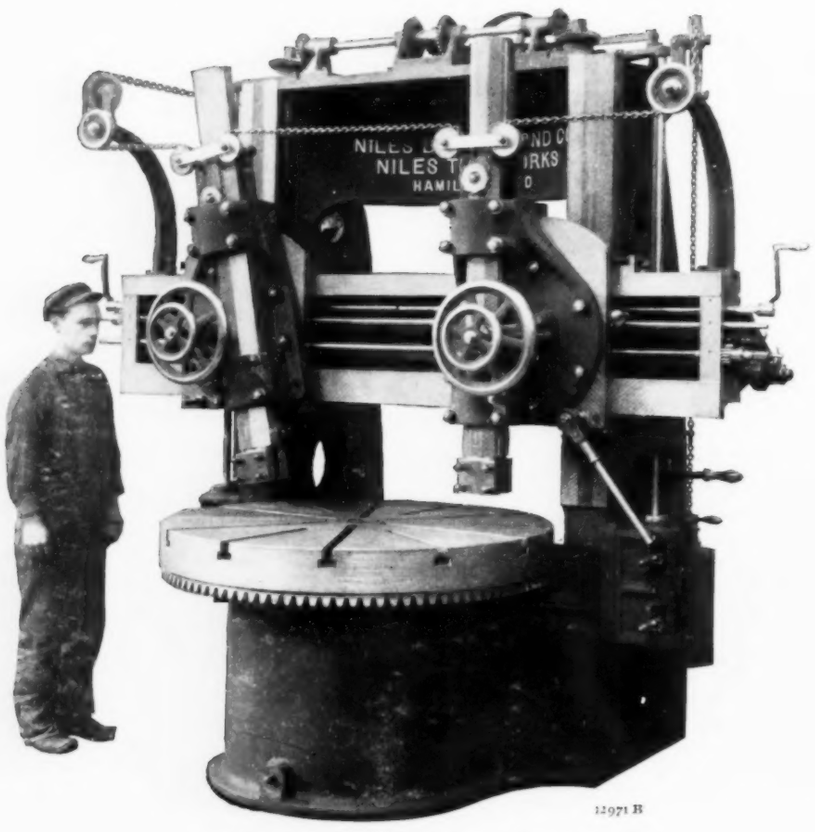
No Belts on the Motor Driven Machines



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(*See pages* 43, 44, 45, 46 *and* 47)

Hardening Room with New Features

By E. F. Lake

A hardening room that was specially designed and built for automobile work in a building of its own. Saw-tooth roof, well ventilated with the light baffled. Light from side windows also baffled and the room lighted with arc electric lights, covered with frosted glass, so as to get a uniform light throughout the day. The entire furnace equipment consists of gas-burning furnaces that may use either the company's producer gas or illuminating gas from the city's supply. The equipment consists of forges and anvils for making tools and high speed and carbon steel furnaces for hardening them, with oil, water or brine quenching baths. For automobile parts there are ordinary and automatic hardening and tempering furnaces, cyanide furnaces, oven furnaces of various sizes, carbonizing furnaces that use gas for the carbonizing material, gas boosters, pumps, air compressors, etc.

A new hardening room has just been completed by the Buick Motor Company, of Flint, Mich. It is located in a building that was specially designed for it, and contains an entire new equipment of furnaces. In this hardening room, with its new equipment and its new methods, the company has been enabled to nearly double its output per man and also to get much more uniform results when hardening a large number of pieces of one kind. Much time and thought were given to a study of the details, when designing the building and hardening room, and consequently it contains many new features that have bettered the quality and quantity of the work.

One can obtain an idea of the size of this hardening room by the general view shown in Fig. 1. This picture was taken from close up to one end of the room and shows the tool forges and furnaces in the far corner.

In the foreground, to the extreme left, are located the tempering furnaces for motor-car parts; and to the extreme right, on the floor, are shown the steel pans that contain the work that is being hardened.

Above these, and to the extreme right, is shown the apparatus from which the soda water is obtained for cleaning the work and also for separating the oil after the work has been cleaned. Beyond this soda-water apparatus is the work bench, and to the right of that are located the carbonizing furnaces that will be shown in later views. Beyond the work bench are located the stock racks, and to the right of them, other carbonizing furnaces.

Baffling the Light

The room has been so designed and constructed that a uniform light is a permanent feature throughout the day, no matter what the weather conditions. The light at night will also be the same as that of daytime. The roof of the building is of saw-tooth construction, built in two sections that run its entire length.

Where glass or windows are usually placed, in this roof there are located sheet-metal slats that resemble a house blind, or shutter, when it is nearly closed. These can be seen in the upper left-hand part of Fig. 1. No glass or covering of any kind is placed over these slats. This gives the room good ventilation at all times, and at the same time shuts out the daylight, which is liable to vary from a bright sunlight to the almost total darkness produced by a thunder cloud.

The side windows are provided with the same framework of sheet-metal slats or blinds, and these are located outside of

Fig. 1. General View of Hardening Room of Buick Motor Company

FIG. 2. TOOL-DRESSING AND HARDENING CORNER

the windows, which may be opened or closed in conformity with the outside weather conditions.

The proper degree, or uniformity, of light is then obtained in the hardening room, by arc lights placed overhead. These have been entirely inclosed with frosted glass, so as to remove any glaring effect and give a subdued light.

TOOL FORGES AND FURNACES

The entire hardening-room equipment was supplied and installed by the American Gas Furnace Company, Elizabeth, N. J. All of the furnaces, forges, etc., use gas for fuel, and are connected up so the gas will flow, as desired, either from the gas-producer plant in the works or from the gas mains that feed the city.

At the end of the room, in Fig. 2, will be seen three open-front forges, with benches beside them, on which to work tools into shape. To the left of these and along the side wall are located inclosed furnaces for heating the stock, and between them is an anvil. In front of these and along the side are located the furnaces in which to heat both high-speed and carbon steels for hardening. Beside them are located steel tanks in which oil or water quenching baths may be used.

QUENCHING BATHS

These quenching tanks, as well as all the others throughout the room, are connected to pipes underneath the floor in such a way that by turning on a cock they will be filled with either oil or water. The baths are so arranged that one will contain oil and the next water, and so on alternately down the entire length of the shop. Sometimes, however, it is desirable to change the baths from

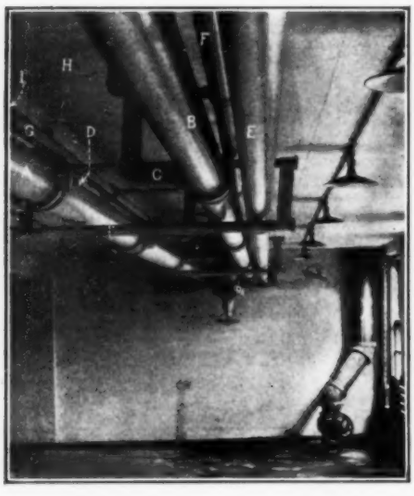


FIG. 3. PIPING FOR FURNACES

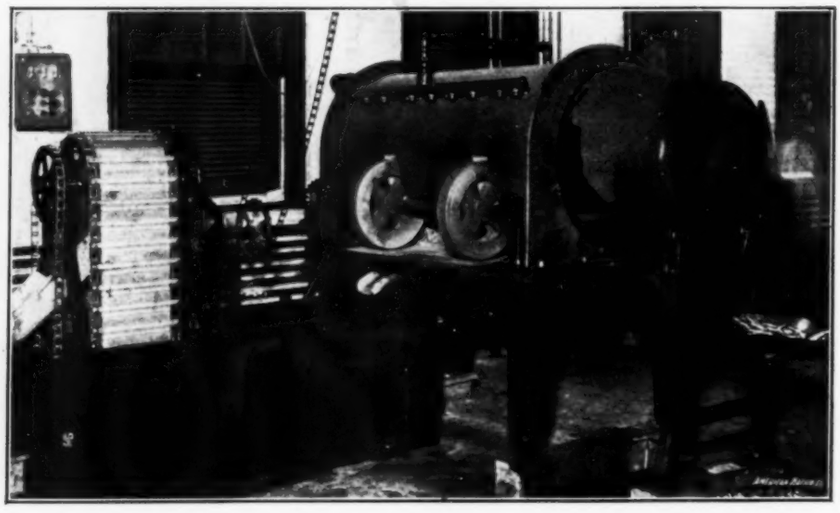


FIG. 4. AUTOMATIC HARDENING AND QUENCHING APPARATUS

oil to water, or *vice versa;* in that case it is only necessary to go into the basement and swing the pipe connections around from one main line to the other.

The piping underneath the floors that conveys the gas, oil and water to the quenching baths is shown in Fig. 3, as it is hung from the ceiling, the upper side of which forms the concrete floor of the hardening room. Beyond the partition that the pipes go through at the far end of this basement, is located a concrete cistern that holds several hundred barrels of oil for use in the quenching baths.

The pipes *A* and *B* are producer- and illuminating-gas pipes respectively. When the company's producers are not giving enough gas to feed the furnaces in the hardening room, the plug *B* is taken out of the city gas main, pipe *C* is swung around and connected and the plug is inserted in the other side. As will be seen, the gas fuel for the furnaces can be changed from the works producer gas to the city gas in a very short time and thus overcome any danger of a shortage of fuel.

Pipe *G* conveys water to the quenching baths, and pipe *F* conveys oil. When it is desirable to change an oil bath to water, the pipe *H*, leading to the quenching bath, is disconnected from oil pipe *F*, and after removing the plug *I* from the water pipe *G*, pipe *H* is swung around and connected to this. A pipe connection similar to *H* leads to each one of the quenching baths in the hardening room, whether it be oil or water. Each quenching bath is also provided with an overflow, and the quenching baths are kept in continuous circulation, in order to keep them at an even temperature. Pipe *E* conveys the air from the air compressors to the furnaces for the air blast.

Automatic Furnace

Next to the tool-hardening furnaces are located the automatic hardening furnace and quenching baths shown in Fig. 4. These have been fully described in former issues of the American Machinist, and hence it is only necessary to say that the work is shoveled into the open end of the furnace. Here it enters a retort that revolves and carries the work through it slowly enough to allow it to attain the proper temperature. The pieces then drop into the quenching bath and travel through that to the conveyer at the extreme left, which elevates them to the chute and drops them into pans, or other apparatus for easily handling the work.

Pin and Cyanide Furnaces

Next to the automatic furnace is located a special furnace for hardening the ends of pins that are about ½ inch in diameter and 3 inches long. This furnace is shown to the right of Fig. 5; it has a plate in front, with eleven holes of sufficient diameter to allow the pins

Fig. 5. Cyanide Furnaces. Special Furnace for Pins

to be easily inserted. The operator puts a cold pin in one hole and pulls a hot pin out of the hole next to it and quenches it. The eleven holes give him just time enough to make the rounds while the pins are attaining the proper temperature for hardening.

Next to that are located six cyanide furnaces, also shown in Fig. 5. The furnaces are located in pairs and the poisonous fumes are piped to the open air by the piping shown.

They are used for hardening such work as valve stems, and these are brought to the furnaces in pans, such as are shown on the tables in front of the furnace. Six of the valves are placed in holes in an iron plate, such as is shown located on top of one of the work pans in front of the cyanide furnace, so that their stems will hang down. The operator then picks up the plate with his tongs and places it in the furnace, so the stems will hang in the cyanide and thus become heated enough for hardening.

Muffle Furnaces

Next to the cyanide furnaces are located four small hardening furnaces and between these are alternated oil and water quenching baths, as shown in Fig. 6. At the end of these is located an oil tempering bath with a thermometer for recording its temperature, as shown to the left.

Fig. 6. Oil-tempering Bath and Small Hardening Furnaces

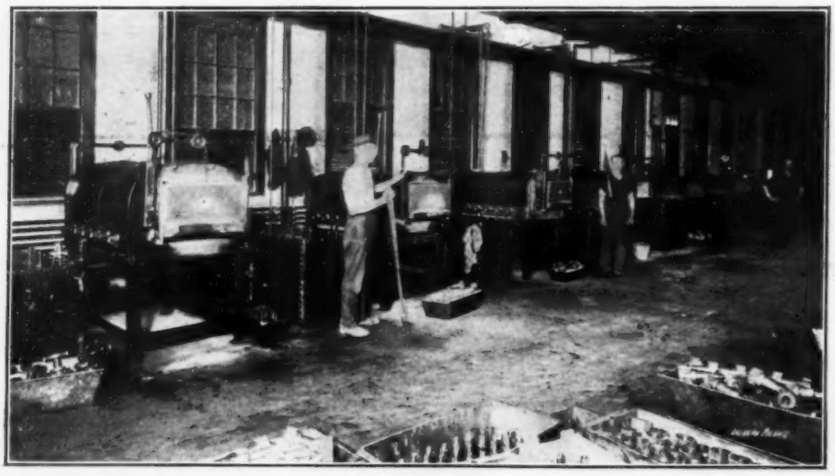


FIG. 7. LARGE HARDENING FURNACES

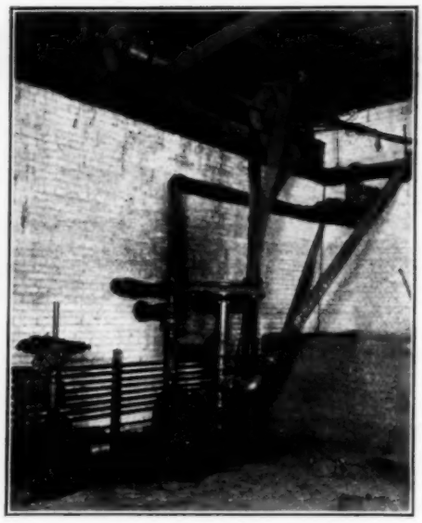


FIG. 8. GAS BOOSTERS

Next to the oil tempering bath are located six hardening furnaces with alternate water and oil quenching baths, as shown in Fig. 7. These are the same style of furnace as the four shown in Fig. 6, but are of a larger size. Some of the work that is being hardened in them is shown in the sheet-metal pans that are scattered around the floor. This, with the preceding halftones, shows the number of furnaces that are lined up on one side of the hardening room.

GAS BOOSTERS

In the corner of the hardening room, opposite the furnaces shown in Fig. 7, are located two different-sized gas boosters, as shown in Fig. 8. When the pressure is not great enough in the city gas main to deliver the required amount of fuel gas to the furnaces, the booster is started working and this sucks the gas from the main in sufficient quanity.

An interesting thing happened when this machine was put in, that shows its power. The city gas main was not delivering a sufficient volume of gas, and therefore the booster was started working. As soon as it started, complaints began to come into the gas company's office from all over the town, that they could either get no gas or not sufficient for lighting purposes. The gas company, therefore, had to put on more pressure so as to get a larger volume of gas into its mains, and eventually were forced to lay a larger main to the works.

In the corner, by the gas booster, is located a concrete tank that was built for a storage tank for oils or other liquids used in the quenching baths. Underneath the gas boosters is located a small cellar that is built entirely of cement. In this are located the pumps and air compressors that are necessary for pumping the oil, brine, water, etc.,

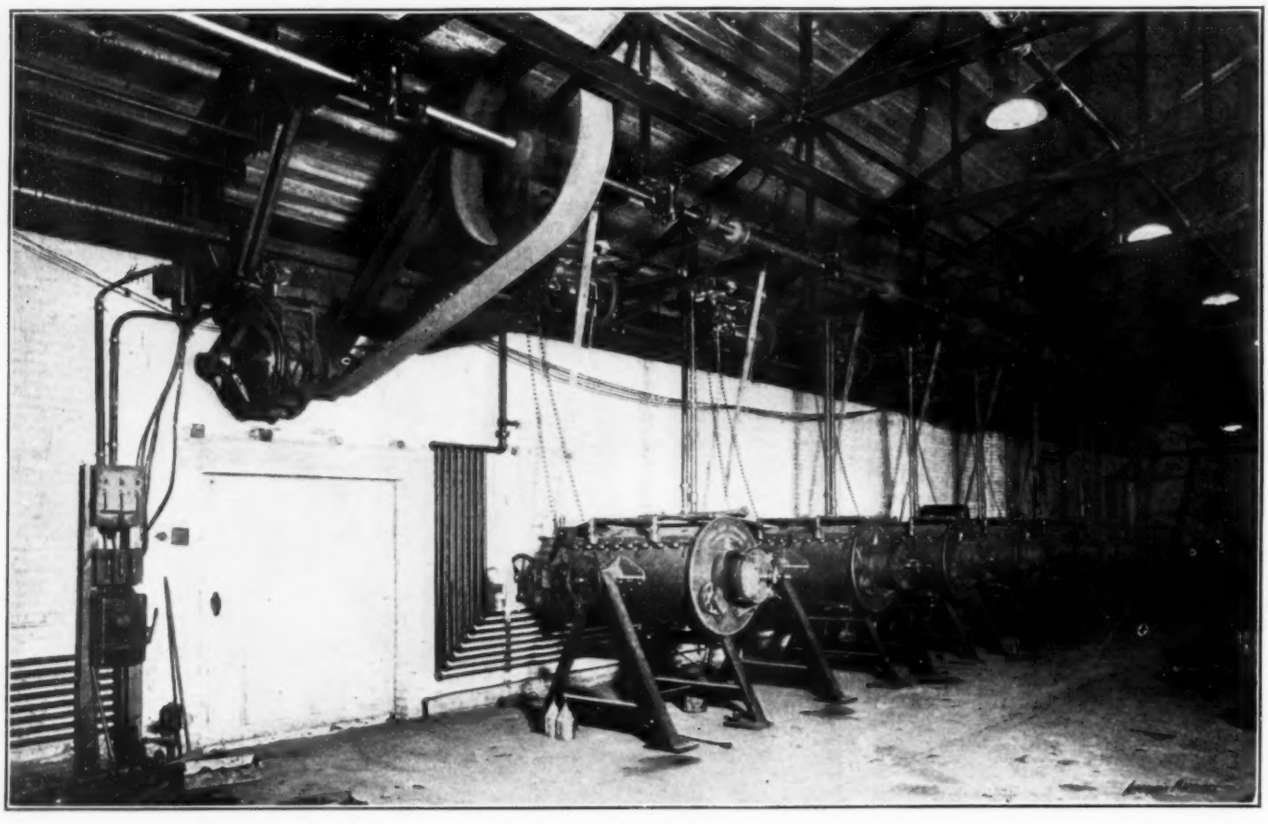


FIG. 9. BATTERY OF FURNACES FOR CARBONIZING WITH GAS

for the quenching baths and for supplying the blast of air to the furnaces.

Carbonizing Furnaces

On the opposite side of the gas boosters is located a battery of six carbonizing furnaces. These furnaces have a central revolving retort for holding the work and consequently require power for their operation. On this side of the hardening room, therefore, is placed all of the apparatus that requires power, and a line shaft is run the whole length of the shop. The line shaft is operated by a motor that is shown hanging from the roof girders, in the left-hand side of the picture. The switchboard for controlling the same is shown below it.

Next to the switchboard is located the

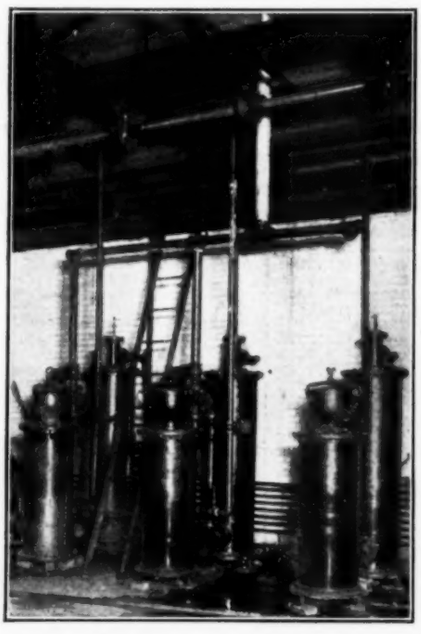


Fig. 10. Carbonizing-gas Generators

apparatus for generating the carbonizing gas that is used in these furnaces. It takes a pair of these cylinders to generate the gas used, and they are arranged here in three sets; any one or two of which may be used, at any time, to supply the furnaces, or the whole three may be used simultaneously.

On the floor in front of the carbonizing furnaces shown in Fig. 9, and between them and the hardening furnaces shown in Fig. 7, the work is assembled on racks for inserting into the retort of the carbonizing furnaces, as shown in Fig. 11. These racks consist of two or three plates according to the size of the work. These plates are drilled with numerous holes to accommodate the different kinds and sizes of work. Long bolts that form rods on which to assemble the work are passed through these holes, and the work and plates are bolted together.

Large Carbonizing Furnaces

Beyond the gas generators shown in Fig. 10 and opposite the corner of the room containing the tool and hardening department shown in Fig. 2 are located two of the largest furnaces that have been built for carbonizing with gas. These are shown in Fig. 12, and next to them are located two of the small size that are used for very small work. Beyond this is shown the work as it is racked up ready for inserting into the furnaces.

Fig. 11. Assembling Work for Carbonizing with Gas

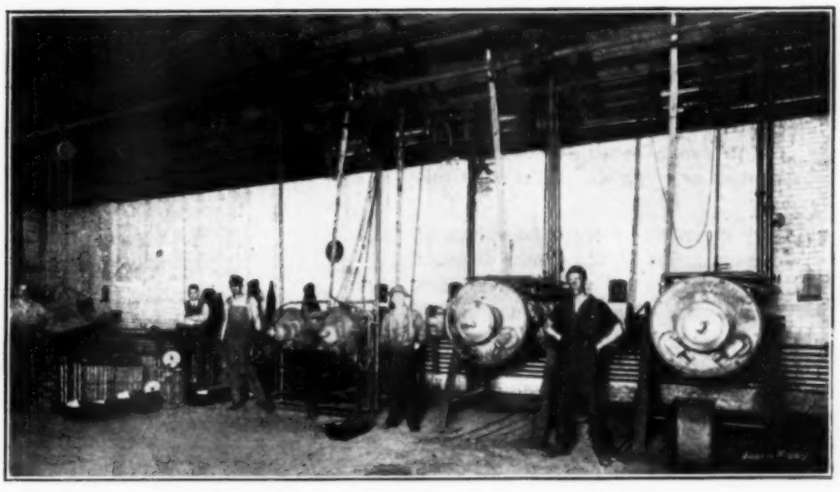


Fig. 12. Overhead Track, Assembled Work and Carbonizing Furnaces

Over this, to the extreme left of the halftone, is shown a scoop for holding the work and conveying it up and down the shop. It is hung from a hoist that runs on an I-beam hanging from the roof trusses. This track runs the whole length of the shop, and is used for conveying or carrying all kinds of work.

With the exceptions of the belt from the motor to the driving pulley of the shaft, no belts are used in the hardening room, as the furnace retorts are revolved by the sprockets and chains, and the friction-pulley countershafts are also revolved by sprockets and chains from the main shaft. This is largely due to the heat of the furnaces, which would burn up and destroy the belt, but it also prevents any slippage and helps keep the retort at a positive number of revolutions per minute.

The work handled in this hardening room is small, and many thousands of pieces are hardened in a day's work. But it moves through the room in a continuous stream, and none of it is held up to block other work and hinder the movements of the operators. It has the reputation of being the largest hardening room in the United States, and doubtless those who read this article will say that it is the best equipped.

Filling a Lard Oil Tank

The machine and lard-oil tanks had, for years, been filled by hand with buckets. A bright employee figured that as water is heavier than oil he could force the oil up into the tank using the city water pressure. A pipe with a valve was put in, connecting the water supply with the spigot hole in the barrel. Another pipe led from the bung hole on *top* of the barrel to the top of the oil tank. When the water was turned on it naturally replaced the oil in the bottom of the barrel, forcing the oil up through the pipe in the bung hole and into the tank.

Direct Solution of Spiral Gear Angles

By J. Butterworth

Spiral gears at 90° angle. A set of tables which cut out guessing and trying.

Tables that will assist in a direct solution of spiral gear angles, given a fixed center distance and normal pitch.

The calculation of spiral gears, where the center distance is fixed, is often a tedious operation, entailing much guessing and trying before a correct solution is obtained. They will, therefore, appreciate the usefulness of the tables given herewith. For all common ratios in use they cut out this work.

For the sake of completeness the various formulas used in the calculations are given with the tables.

Few words of explanation as to the method of using the tables are necessary.

From the list of formulas we notice that center distance

$$D = \frac{r}{2p}\left(\frac{R}{\sin. a} + \frac{1}{\cos. a}\right)$$

that is

$$D = \frac{r}{p} M$$

where

$$M = \tfrac{1}{2}\left(\frac{R}{\sin. a} + \frac{1}{\cos. a}\right).$$

In the tables this value M has been calculated for all the common ratios R and for a full range of values of angle a. The method of using the tables is as follows:

In any given set of gears the values of R, the gear ratio; D, the center distance and p, the diametral pitch, have been previously settled by external considerations.

First select a value for the number of teeth in the pinion (r) which will give a whole number of teeth (T) in the wheel and from the formula

$$D = \frac{r}{p} M$$

calculate a value for M thus,

$$M = \frac{Dp}{r}$$

r should be so selected as to give the smallest value of M possible; care being taken not to fall below the minimum value for M stated at the foot of the table. By doing so the greatest number of teeth possible will be put in the gear and pinion and consequently a quiet running gear will result.

In practice it will be found to be possible to mentally select the value of r which will give a suitable value for M as the numbers D, p and r are as a rule low whole numbers.

An example will make matters clear. Suppose we want a pair of gears with ratio $R = \frac{5}{8}$, to gear at 8-inch centers; to be 5 diametral pitch. In the formula

$$M = \frac{Dp}{r}$$

mentioned above Dp for this case $= 40$. From the table the minimum for $M =$ 2.3955. A mental trial with various values of r shows that for $r = 16$ $M = 2\frac{1}{2}$ and for $r = 18$, $M = 2.2222$. Sixteen teeth is, therefore, the largest value of r possible. This gives a value for $T = 40$ teeth. We now take three values for M from the table in the neighborhood of the value of M found by this calculation and plot on squared paper—kept handy—to a large scale. I use paper about 10x12 inches with millimeter squares and find I get results within 0.002 inch of the correct center distance. Angle a is plotted horizontally and values of M vertically. In the case under consideration the values taken from the table are

$a = 60°$ $M = 2.4433$
$a = 65°$ $M = 2.5623$
$a = 70°$ $M = 2.7922$

These values plotted show the value of the angle a corresponding to $M = 2.5$ to be 65 degrees 51 minutes.

It will be found that there are usu-

Values of the Angle A.	Values of the Ratio R.							
	1–1	10–9	9–8	8–7	7–6	6–5	5–4	9–7
3 deg.	10.0543	11.1158	11.2485	11.4191	11.6466	11.9650	12.4427	12.7839
5	6.2387	6.8761	6.9558	7.0583	7.1948	7.3861	7.6729	7.8778
7	4.6065	5.0624	5.1193	5.1925	5.2902	5.4270	5.6322	5.7786
10	3.3871	3.7070	3.7470	4.7985	3.8670	3.9630	4.1069	4.2098
15	2.4494	2.6640	2.6909	2.7253	2.7714	2.8358	2.9323	3.0013
20	1.9940	2.1564	2.1767	2.2029	2.2376	2.2864	2.3595	2.4117
25	1.7348	1.8663	1.8827	1.9038	1.9319	1.9714	2.0306	2.0728
30	1.5773	1.6884	1.7023	1.7201	1.7440	1.7773	1.8273	1.8630
35	1.4821	1.5790	1.5911	1.6066	1.6273	1.6564	1.7000	1.7311
40	1.4305	1.5169	1.5277	1.5416	1.5601	1.5861	1.6250	1.6527
45	1.4142	1.4928	1.5026	1.5153	1.5321	1.5556	1.5910	1.6163
50	1.4305	1.5030	1.5121	1.5238	1.5392	1.5610	1.5937	1.6170
55	1.4821	1.5499	1.5584	1.5693	1.5838	1.6042	1.6347	1.6565
60	1.5773	1.6414	1.6495	1.6597	1.6735	1.6928	1.7216	1.7422
65	1.7348	1.7961	1.8038	1.8137	1.8268	1.8451	1.8727	1.8925
70	1.9940	2.0531	2.0605	2.0700	2.0826	2.1004	2.1270	2.1460
75	2.4494	2.5069	2.5141	2.5234	2.5357	2.5529	2.5788	2.5973
80	3.3871	3.4435	3.4506	3.4597	3.4718	3.4886	3.5140	3.5322
83	4.6065	4.6625	4.6695	4.6784	4.6905	4.7073	4.7324	4.7504
85	6.2387	6.2945	6.3014	6.3104	6.3223	6.3391	6.3642	6.3821
87 deg.	10.0543	10.1099	10.1169	10.1258	10.1377	10.1544	10.1795	10.1973
M minimum	1.4142	1.4922	1.5017	1.5141	1.5305	1.5535	1.5877	1.6120
Angle A for M minimum.....	45° 0′	46° 0′	46° 7′	46° 16′	46° 28′	46° 44′	47° 8′	47° 24′

TABLE OF VALUES OF M. SHEET 1

Values of the Angle A.	Values of the Ratio R.							
	4–3	7–5	10–7	3–2	8–5	5–3	7–4	9–5
3 deg.	13.2388	13.8757	14.1487	14.8311	15.7864	16.4234	17.2195	17.6971
5	8.1510	8.5335	8.6973	9.1071	9.6809	10.0632	10.5413	10.8283
7	5.9741	6.2475	6.3647	6.6578	7.0680	7.3416	7.6835	7.8885
10	4.3469	4.5389	4.6211	4.8268	5.1148	5.3067	5.5466	5.6907
15	3.0933	3.2222	3.2773	3.4153	3.6086	3.7373	3.8983	3.9950
20	2.4813	2.5788	2.6205	2.7249	2.8712	2.9686	3.0904	3.1636
25	2.1292	2.2080	2.2418	2.3263	2.4446	2.5235	2.6221	2.6812
30	1.9106	1.9773	2.0059	2.0773	2.1773	2.2440	2.3273	2.3773
35	1.7727	1.8307	1.8556	1.9179	2.0050	2.0632	2.1358	2.1793
40	1.6898	1.7417	1.7638	1.8194	1.8973	1.9490	2.0139	2.0529
45	1.6499	1.6970	1.7173	1.7678	1.8384	1.8856	1.9446	1.9794
50	1.6481	1.6915	1.7102	1.7568	1.8220	1.8657	1.9200	1.9525
55	1.6856	1.7263	1.7437	1.7873	1.8484	1.8890	1.9399	1.9705
60	1.7697	1.8083	1.8247	1.8659	1.9238	1.9622	2.0103	2.0393
65	1.9187	1.9554	1.9713	2.0107	2.0657	2.1026	2.1486	2.1760
70	2.1714	2.2068	2.2220	2.2600	2.3132	2.3487	2.3930	2.4196
75	2.6219	2.6564	2.6712	2.7082	2.7599	2.7945	2.8376	2.8634
80	3.5563	3.5901	3.6047	3.6410	3.6916	3.7256	3.7679	3.7931
83	4.7744	4.8081	4.8224	4.8584	4.9089	4.9424	4.9843	5.0097
85	6.4060	6.4395	6.4538	6.4896	6.5399	6.5733	6.6151	6.6403
87 deg.	10.2212	10.2545	10.2688	10.3046	10.3546	10.3881	10.4298	10.4547
M minimum	1.6443	1.6891	1.7083	1.7559	1.8219	1.8657	1.9200	1.9524
Angle A for M minimum.....	47° 44′	48° 12′	48° 24′	48° 52′	49° 28′	49° 51′	50° 19′	50° 35′

TABLE OF VALUES OF M. SHEET 2.

Values of the Angle A.	Values of the Ratio R.							
	2–1	9–4	7–3	5–2	8–3	3–1	10–3	7–2
3 deg.	19.6080	21.9964	22.7925	24.3847	25.9770	29.1615	32.3460	33.9383
5	11.9756	13.4098	13.8879	14.8439	15.8001	17.7123	19.6246	20.5807
7	8.7093	9.7349	10.0769	10.7605	11.4444	12.8119	14.1795	14.8632
10	6.2665	6.9863	7.2263	7.7062	8.1861	9.1459	10.1057	10.5856
15	4.3813	4.8642	5.0252	5.3471	5.6691	6.3130	6.9569	7.2789
20	3.4559	3.8214	3.9432	4.1868	4.4305	4.9178	5.4051	5.6487
25	2.9179	3.2137	3.3123	3.5094	3.7067	4.1010	4.4954	4.6925
30	2.5773	2.8273	2.9106	3.0773	3.2439	3.5773	3.9106	4.0773
35	2.3538	2.5717	2.6444	2.7897	2.9350	3.2255	3.5161	3.6614
40	2.2084	2.4028	2.4677	2.5972	2.7269	2.9861	3.2454	3.3750
45	2.1213	2.2981	2.3570	2.4749	2.5927	2.8284	3.0641	3.1820
50	2.0832	2.2464	2.3008	2.4095	2.5184	2.7359	2.9535	3.0622
55	2.0925	2.2451	2.2960	2.3977	2.4995	2.7029	2.9064	3.0081
60	2.1547	2.2990	2.3471	2.4433	2.5395	2.7319	2.9243	3.0211
65	2.2865	2.4244	2.4704	2.5623	2.6543	2.8382	3.0221	3.1140
70	2.5261	2.6591	2.7035	2.7922	2.8809	3.0582	3.2356	3.3243
75	2.9671	3.0965	3.1396	3.2258	3.3121	3.4846	3.6571	3.7434
80	3.8948	4.0217	4.0640	4.1486	4.2332	4.4025	4.5717	4.6563
83	5.1102	5.2362	5.2781	5.3622	5.4461	5.6141	5.7820	5.8660
85	6.7406	6.8661	6.9079	6.9915	7.0752	7.2425	7.4098	7.4934
87	10.5550	10.6802	10.7219	10.8054	10.8888	11.0557	11.2226	11.3061
M. minimum Angle A for Minimum.....	2.0809	2.2393	2.2916	2.3955	2.4986	2.7028	2.9045	3.0045
	51° 34′	52° 39′	52° 59′	53° 37′	54° 12′	55° 16′	56° 12′	56° 38′

TABLE OF VALUES OF M. SHEET 3.

ally two values of the angle a which will give a value of M fulfilling the conditions. The angle a which should be used in these circumstances is the one which gives the largest angle of spiral to the *driving* gear.

The complete calculations for the case above are here appended.

Angle $a = 62° 51'$

Pitch diameter of pinion =

$$\frac{r}{p \cos. 62° 51'} = \frac{16}{5 \times 0.4563} = 7.011''$$

Pitch diameter of wheel =

$$\frac{r}{p \sin 62° 51'} = \frac{40}{5 \times 0.8898} = 8.991''$$

Twice the center distance = 16.002″

Center distance inaccuracy = 0.001″

It will be seen that this method gives results quite accurate enough for every practical purpose. It is also a rapid method—five minutes suffices for obtaining the angle required to fulfil the conditions.

Formula for spiral gears at 90-degree angle.

Let

T = Teeth in wheel

r = Teeth in pinion

p = Normal diametral pitch

D = Center distance

$R = \frac{\text{Speed of pinion}}{\text{Speed of wheel}} = \frac{T}{r}$

a = Center angle of pinion

$(90 - a) = b$ = Center angle of wheel.

Center distance

$$D = \frac{r}{2p}\left(\frac{R}{\sin. a} + \frac{1}{\cos. a}\right).$$

For any given ratio R,

$$D = \frac{r}{p} M$$

where

$$M = \tfrac{1}{2}\left(\frac{R}{\sin. a} + \frac{1}{\cos. a}\right)$$

and

$$M = \frac{D p}{r}.$$

Minimum value of M is where $\tan. a = \sqrt[3]{R}$.

Method of calculation given D, R and p.

(1) Select r so that $M \left(\text{in } M = \frac{D p}{r}\right)$ exceeds the minimum.

(2) Find the value of a by plotting 3 values of M from the tables.

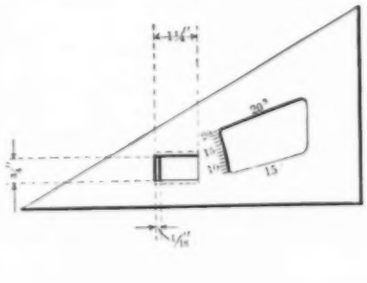
Values of the Angle A.	Values of the Ratio R.							
	4–1	9–2	5–1	6–1	7–1	8–1	9–1	10–1
3 deg.	38.7151	43.4919	48.2687	57.8223	67.3759	76.9295	86.4831	96.0367
5	23.4491	26.3175	29.1859	34.9227	40.6595	46.3963	52.1331	57.8699
7	16.9146	18.9659	21.0173	25.1200	29.2227	33.3254	37.4281	41.5308
10	12.0253	13.4650	14.9047	17.7841	20.6635	23.5429	26.4223	29.3017
15	8.2448	9.2107	10.1766	12.1084	14.0402	15.9720	17.9038	19.8356
20	6.3797	7.1106	7.8416	9.3035	10.7654	12.2273	13.6892	15.1511
25	5.2841	5.8756	6.4672	7.6503	8.8334	10.0165	11.1996	12.3827
30	4.5773	5.0773	5.5773	6.5773	7.5773	8.5773	9.5773	10.5773
35	4.0972	4.5331	4.9689	5.8406	6.7123	7.5840	8.4557	9.3274
40	3.7639	4.1528	4.5417	5.3195	6.0973	6.8751	7.6529	8.4307
45	3.5355	3.8891	4.2426	4.9497	5.6568	6.3639	7.0710	7.7781
50	3.3886	3.7149	4.0413	4.6940	5.3467	5.9994	6.6521	7.3048
55	3.3133	3.6185	3.9237	4.5341	5.1445	5.7549	6.3653	6.9757
60	3.3092	3.5984	3.8865	4.4638	5.0411	5.6184	6.1957	6.7730
65	3.3899	3.6657	3.9416	4.4933	5.0450	5.5967	6.1484	6.7001
70	3.5903	3.8564	4.1224	4.6545	5.1866	5.7187	6.2508	6.7829
75	4.0022	4.2610	4.5198	5.0374	5.5550	6.0726	6.5902	7.1078
80	4.9102	5.1640	5.4179	5.9256	6.4333	6.9410	7.4487	7.9564
83	6.1179	6.3698	6.6217	7.1255	7.6293	8.1331	8.6369	9.1407
85	7.7444	7.9953	8.2463	8.7482	9.2501	9.7520	10.2539	10.7558
87 deg.	11.5564	11.8068	12.0571	12.5578	13.0585	13.5592	14.0599	14.5606
M. minimum Angle A for Minimum.....	3.3018	3.5956	3.8865	4.4613	5.0286	5.5899	6.1471	6.7000
	57° 47′	58° 48′	59° 41′	61° 10′	62° 24′	63° 26′	64° 20′	65° 6′

TABLE OF VALUES OF M. SHEET 4.

A Draftsman's Triangle

By J. B. Haskell

The cut shows some alterations that I have made in an ordinary 30x60-degree celluloid triangle that have proved to be very convenient and useful. I cut the inner sides to angles of 20 degrees and 15 degrees, and made a protractor from 8 to 20 degrees. The other cut place is a section liner. It was made by making two straight cuts through the material, each cut taking out 32 inches or leaving 1/32 inch opening. These cuts are then joined by V's cut in from each side as shown in



A Draftsman's Triangle

section, thus making the small piece free to slide 1/16 inch (or whatever amount may be desired) but held from dropping out. In use the forefinger is pressed on the small slide and the triangle held by the other fingers. A line is drawn, then the finger slips the slide to the right and presses down and holds it. Then slide the triangle the 1/16 inch till it stops. With a little practice section lining can be done rapidly and accurately. Different spacings may be made according to whether the 30-degree or 90-degree side is used to rule from.

The Mexican post-office department is preparing to establish an automobile mail route from Iguala to Chilpancingo, the capital of the state of Guerrero. This is a distance of 69 miles and the specifications call for round trips every day of the year to be made in 5 hours each way. This will be over a new roadway forming part of the Mexico-Acapulco highway. It is said to be the longest automobile route yet established.

Data on Manufacturing Machine Tools*

By Luther D. Burlingame†

A topical discussion upon a subject of importance and interest to mechanics, with details of feeds and speeds used in milling, the rate of production, the amount of material removed and power required.

*Presented at joint meeting of American Society of Mechanical Engineers and Institution of Mechanical Engineers.

†Chief draftsman, Brown & Sharpe Manufacturing Company.

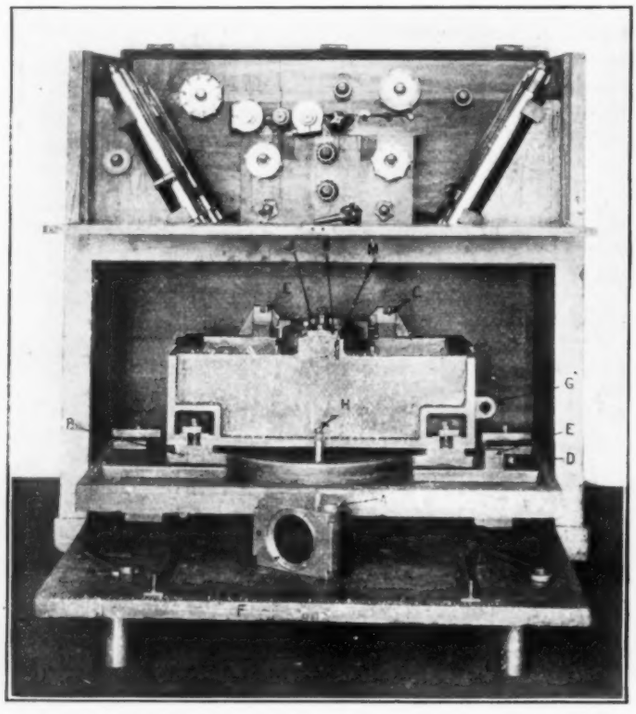
The extensive set of special tools required to make a modern machine tool on a manufacturing basis and to attain the degree of accuracy required is indicated by the tool equipment for making the spiral-head swivel for a universal milling machine. The tools required for making it are listed below:

a Boring fixture and tools in cupboard
b Counterbalance for grinding
c Driver for turning
d Counterbore for spindle rear-washer seat
e Jig for drilling front-bushing screw holes
f Reamer for index stop-pin hole
g Taper reamer and test plug
h Roughing and finishing taper reamer
i Arbor for turning
j Jig for drilling worm-shaft bushing stop screw hole
k Jig for drilling oil and screw holes
l Jig for finishing drilling-spindle stop pin hole
m Milling cutter
n Fixture for graduating
o Fixture-testing graduations
p Test plug
q Bushing for testing rear bearing
r Device for testing

A Boring Fixture

Among these tools the fixture for boring has been selected as typical of the extent of the equipment necessary for the production of such parts. Figs. 1 and 2 show this fixture in the cupboard made to store it when not in use, and in front is a spiral-head swivel for the manufacture of which the fixture was designed. The boring bars and cutting tools have their proper place in the top section of the cupboard, being so grouped that the tools for use in each position are together. The fixture itself is placed on a carriage in the lower part, this carriage being mounted on wheels which are guided on a track. When the front door is opened a section of track attached to it and matching the track in the cupboard provides that the carriage can be drawn out to a position where it can be readily lifted onto the boring mill. A hook on the end of each rail prevents the carriage from being run off onto the floor.

This boring fixture is of special interest in that it can be set to bore the swivel in three positions without removing it from the fixture. As set in Fig. 1 it is in position to bore holes *A*. After these are bored the swinging plate *B* is unclamped and the upper part of the fixture turned end for end so that other holes on the opposite side to the holes *A* can be bored. The swinging plate *B* is then turned at right angles to its former position and the upper part swung on trunnions provided so that lugs *C* can be clamped by bolts *D* upon the seat *E*, as shown in Fig. 2. This brings the fixture in position to face at *F*, and bore the hole for the spindle bearing, etc. The cover *J*, hinged to allow placing the work in the fixture, is clamped by a strap *K* which can be loosened and turned half way around to disengage it from the cover without removing the bolt. The lug *G* is for the insertion of a bar to aid the workman in swiveling the fixture so that one man can operate it. The plug *H* fitting in a taper hole for each position insures the setting of the fixture so that all holes will be in perfect alinement. The slot *M* is for the insertion of a taper wedge which, coming against the face of the swivel, locates it in proper position before it is clamped in place. When not in use the cupboard is completely closed and locked.



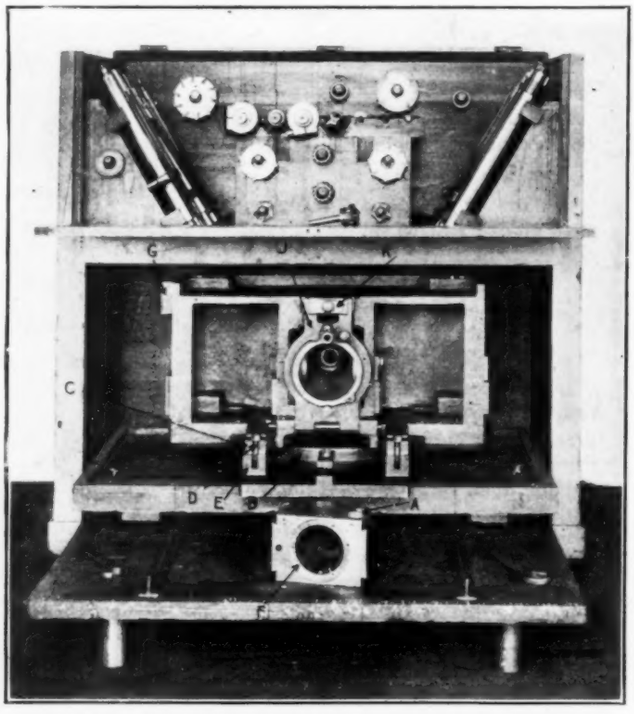


Fig. 1 Two Views of a Boring Fixture for Spiral-head Swivels Fig. 2

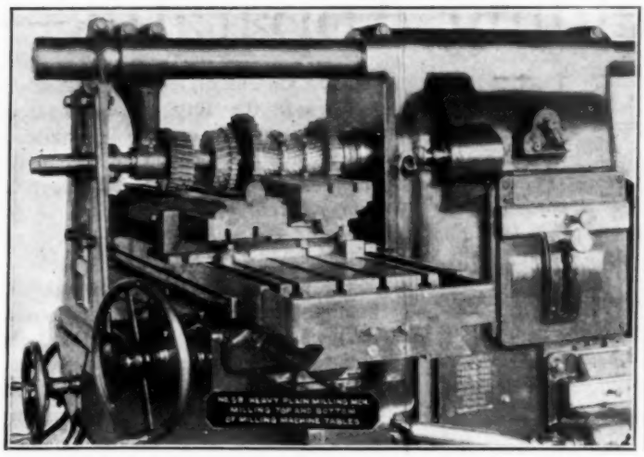
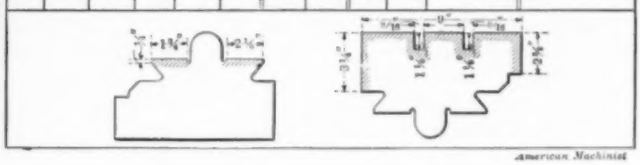


FIG. 3. MILLING TOP AND BOTTOM OF MILLER TABLES

Milling done on No. 5 B. Heavy Plain Milling Mach. Lot 25.....
Operation Milling Top and Bottom of 50 No. 1 Univ. Mill. Mach. Tables.
Photograph Negative C.-1045. Date June 3, 1907. Brown & Sharpe Mfg. Co., Providence R.I. U.S.A.

Cutter						Feed		Size of Cut			Material
R.P.M	Surface Speed	Diam.	Style		Matl.	Per. Rev.	Per. Min.	Width	Depth	Amount in Cubic Inches	
	65′	1- 9½″	Side		High Speed						
	80′	1- 11½″	Side		High Speed						
26	55′	2- 7⅞″	Side		High Speed	.078″	2.0025	25.75″	.1875	9.958	Hard Cast Iron
	48′	2- 7⅞″	Plain		High Speed						
	32′	3- 4⅝″	Plain		Carbon						
	47′	2- 6 21/32″	Slott		High Speed						



American Machinist

FIG. 4. DATA CARD FOR MILLING OPERATION

MILLING TOP AND BOTTOM OF MILLING-MACHINE TABLES

Fig. 3 is an example of milling in which the top of one table and the bottom of another table of a universal milling machine are milled at one traverse of the machine, the milling being done on a Brown & Sharpe No. 5-B heavy plain milling machine. At the completion of

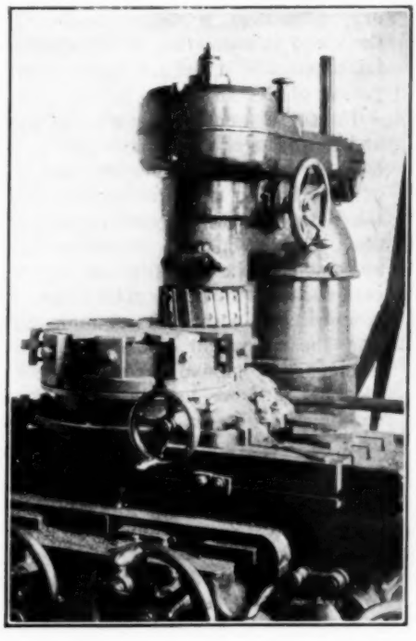


FIG. 5. CONTINUOUS MILLING OPERATION

the cut one table is removed and the other one, which has been milled on the top only, is turned over so that the bottom may be milled while a rough casting is put in its place and the cut repeated. This illustrates economy in handling the work as well as in the time of milling. In Fig. 4 is a data sheet for this operation, made out on a printed form such as is used by the Brown & Sharpe Manufacturing Company for such tests and the data given are for regular production under manufacturing conditions. It will be noticed that while the large cutters are of high-speed steel, the small cutters running at much lower surface speed are of ordinary carbon steel.

AN EXAMPLE OF HEAVY MILLING

An example of heavy milling on a machine of the same size and type as used for the milling-machine tables is to be had in tests made on a steel block of 65,000 pounds tensile strength. Eighteen cubic inches of metal were removed per minute. The output of the motor was 21.05 horsepower, making 0.85 cubic inch removed per net horsepower. At no time during the test did the machine show signs of distress or appear to labor excessively, and the notable absence of vibration was emphasized in the following manner. A coin was placed upon its edge at one end of the table with its sides at right angles to the axis of the

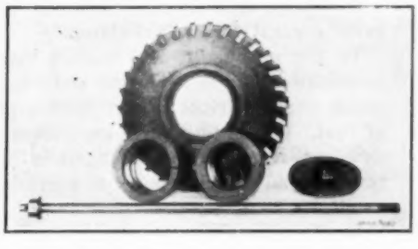


FIG. 6. BROWN & SHARPE INSERTED-TOOTH MILLING CUTTER

table, and on the opposite end a full glass of water was placed. The machine was then started and many cuts taken without overturning the coin or spilling any of the water.

A feature of note in connection with this test was the efficiency of the high-speed steel cutters employed. One gang removed 1800 cubic inches of steel without having to be removed from the arbor for sharpening.

CONTINUOUS MILLING OPERATION

Fig. 5 gives an example of continuous milling on a Brown & Sharpe No. 5 vertical-spindle milling machine. In this case ten flat-iron bottoms were held in a special fixture on the circular milling attachment. The table makes one complete revolution in 4 minutes, thus finishing the surface of ten flat irons in 4 minutes, or 150 per hour. The fixture is so made that the workman can easily replace the work so as to keep the machine going continuously. The cut on each piece is about 8 inches long, 4¼ inches wide at the widest part and about 1/16 inch deep.

Fig. 6 shows the style of inserted-tooth cutter used, this cutter, being of a design which avoids undue projection beyond the end of the spindle, allows the cutter to be easily removed, and also makes it possible to use the same cutter on machines with different sizes of spindles.

My Busy Day in Germany

In the reception room of many German machine-shop offices a sign is conspicuously displayed bearing this legend:

Sag, was du wilst kurz und bestimmt,
Lass, alle schönen Phrasen fehlen!
Wer untzlos unserer Zeit uns nimmt,
Bestiehlt uns und: "Du sollst nicht stehlen."

A friend of the AMERICAN MACHINIST has freely translated it in the following lines:

Say what you want and say it quick.
Leave out the useless spiel.
You steal from us by wasting time.
Beware! "Thou shalt not steal."

Many shops are using photography as an aid to keeping an inventory of the machinery and tools. Views taken at different points make an unmistakeable record of the number of machines installed at that date.

Oxy-Acetylene Welding, Apparatus—I

By E. F. Lake

The growth of the process and the inventions that made it possible. The power behind the two gases and how they have been controlled for commercial use. The combustibility and explosiveness of acetylene and the methods of safely applying it for welding metals. The chemical combinations with oxygen that cause it to generate light and heat.

The kind of torches designed and used for the mixing and burning the two gases with safety. The causes of the flame flashing back to the torch and the necessity of flash-back preventers, as well as the kinds used on the various torches. The nature of and conditions produced by the flame as it leaves the torch and the effect on the metal being welded.

The impurities in the two gases and their effect upon welds.

Owing to the simplicity of the apparatus and the ease of operation, the use of the oxy-acetylene process of welding has spread very rapidly and its applications have multiplied since its introduction into this country, less than five years ago. Today it has become one of the necessary adjuncts of the uptodate machine shop, and a large number of foundries have also installed the apparatus, while those that have not are contemplating so doing or placing orders for it.

This has caused many new firms to start in the manufacture of welding apparatus, with the result that there is a choice of several ways of obtaining the necessary gases. They can either be bought in retorts in which they are stored, or apparatus for generating the gases on the premises, by several different methods, can be obtained.

Likewise, numerous styles of torches can be obtained in which to mix the gases and produce the flame used in the welding. Almost all of the metals are being welded in the manufacture of various articles.

Power of Gases

The rapid development of this system of welding and the inert power of the gases used in the process has caused many fatal and damaging accidents. Anything as powerful as the two gases used, which generate a heat of 6300 degrees Fahrenheit, must of necessity be dangerous to use when handled by those ignorant of their nature and the way in which they act. But when these same gases are handled intelligently and properly, their great power can be safely made to lighten man's labor by enabling him to manufacture products in a quicker, easier and more economical way.

Thus, while the process is here to stay and several firms make apparatus in which the gases can be safely controlled, it seems to us time to sound a friendly note of warning to those who are trying to cheapen the apparatus, as they thus make these gases dangerous to handle.

The subject has become so important that the National Board of Fire Underwriters has held several meetings in which to discuss restrictions that have been suggested. These have thoroughly been discussed and cover the torches, piping, generators, storage tanks, scrubbers, etc., and no doubt they will soon be adopted and made public.

Application of Acetylene

Although acetylene has been known chemically since 1836, when it was discovered by Edmund Davy, and has been used more or less in an experimental way since that time, it was only a laboratory product until the year 1894. Due to the development in the electric furnace, calcium carbide was then obtained from a mixture of powdered lime and carbon that were submitted to the action of the high temperatures of the electric furnace.

This was done almost simultaneously by Henri Moissan, in France, and Thomas L. Willson, in this country. Through the efforts of the latter, calcium carbide was made a commercial product and became a great factor in lighting.

To the chemist it was known that a combination of the acetylene and oxygen gases would produce a very high degree of heat. Owing to its high explosiveness, however, it was a very dangerous mixture to handle, and it was not possible to use it commercially until 1902.

In other words it took eight years, after calcium carbide became a commercial product, to develop and perfect a torch in which acetylene and oxygen could be mixed and safely handled for the welding and cutting purposes that it is now largely used for.

This torch was so constructed that it would prevent the flame from flashing back into the gas retorts and thus cause an explosion. This was the secret of the successful application of these gases to the manufacturing and repairing of metal products. Since then several different designers of torches have successfully adopted various styles of flash-back preventers in the form of fine-mesh wire screens, porous earth, automatic stop valves, fine tubes coiled up several times, many small tubes squeezed into a large tube, as well as other methods.

Combustibility of Acetylene

The reason acetylene is so highly combustible and explosive is that it contains 92.3 per cent. of carbon, the balance being hydrogen, a part of which may be phosphorated and sulphureted, and small percentages of other impurities. Oxygen has a great affinity for carbon, especially in the presence of heat. Thus, when an atom of carbon comes within the influence of an atom of oxygen, they rush toward each other with a speed that continually increases the nearer they approach.

This speed is similar to that of a body falling to the earth. They seldom strike, but revolve around each other on an orbit similar to the one in which the earth travels around the sun. This combination is called a molecule; their coming together is what forms combustion; the revolving around each other, or the energy of motion, produces the heat, and the speed at which they travel when coming together is called the speed of propagation of the flame.

The combination of one atom of oxygen and one atom of carbon is called carbonic oxide or carbon monoxide, and is expressed by the chemical symbol CO. It takes two atoms of oxygen to satisfy one atom of carbon and consequently the movement of the atoms toward each other continues until this point has been reached. Then there is no more attraction, the movement or energy of motion is stopped, combustion ceases, the flame dies out, and we have a product called carbonic acid gas or carbon dioxide, which is expressed by the chemical symbol CO_2.

Explosiveness of Acetylene

When acetylene escapes into the air in a steady stream of small volume, it will drift away and become lost in the numerous air currents and have no bad effects. If heat is applied at the point of escape in the form of a flame, combustion is started. By controlling the volume and flow, a brilliant white light is obtained that is used for illuminating purposes.

If, however, the acetylene escapes into an inclosure, such as a room, the volume will soon become so great that when a flame is applied, it immediately raises the temperature and starts an energetic movement of the oxygen toward the carbon. The speed of propagation of the flame then becomes so great that it almost

instantly permeates the entire mass, resembles a flash of lightning and causes an explosion. The real difference between combustion and explosion is in the speed of propagation of the flame, a high speed causing an explosion and a relatively slow one causing combustion.

The hydrogen in the air has a tendency to retard the rush of the oxygen and carbon atoms toward each other, and the speed of propagation of the flame is thus slower than if the hydrogen were not present. For this reason pure oxygen is mixed with the acetylene to generate the flame for welding purposes, and this makes the hottest flame that has ever been produced as a product of combustion. The temperature nearly reaches that of the electric arc and is 6300 degrees Fahrenheit.

As heat starts or greatly accelerates the speed of the atoms of oxygen toward the atoms of carbon, it has always been a very dangerous proposition to compress acetylene. When acetylene was compressed to over 15 pounds per square inch a considerable quantity of heat was generated and this made it very explosive.

Torches Needed

To combine two such powerful gases and utilize them commercially, it was necessary to use a torch in which they could be brought together, mixed and then burned at the tip. The torch must be light enough to be easily handled and at the same time strong enough to hold together and withstand the high temperature to which it was submitted. The gases had to be carried close to the tip before mixing them, and their quantity made as small as possible. Stop valves were necessary on each of the gas-supply pipes, and these placed in a position in which they could be easily handled while working the torch.

To connect to the gas supply it was necessary to do it in such a manner as would allow the torch to be carried all around the job that was being welded. This necessitated the use of a good-quality three-ply rubber hose that was protected against abrasion and kinking by a flexible outer cover. The hose should be able for five minutes to withstand a pressure of 400 pounds per square inch. In making connections the hose should be clamped to substantial fittings in such a manner as to withstand a pressure, without leaking, that is twice as great as that obtained through the regulating valves provided on the system.

Low-pressure Torch

The torch was developed along two distinct lines simultaneously, namely, the high-pressure and low-pressure torch.

The low-pressure torch was based on the principle of the injector and the acetylene was drawn into it by the suction produced by the flow of oxygen under pressure. The pressure of the oxygen in the torch and hence its flow are regulated by reducing valves on the oxygen-storage tank as well as by the area of the torch nozzle. The acetylene being delivered to the torch under a pressure of only a few ounces, it is drawn into it by the higher speed of the oxygen and these are then mixed in a mixing chamber near the nozzle of the torch.

It is essential that the proportion of acetylene be constant, and hence it is necessary to use reducing valves to control the flow of oxygen. The law has been well established that the volume of fluid sucked by an injector is proportional to the square of the velocity of the propelling fluid.

An ordinary acetylene-lighting generator can be used with this torch and the oxygen can either be taken from the steel bottles in which it is compressed and sold or from the different kinds of apparatus that generate oxygen on the premises. The proportional volume of the two gases used at atmospheric pressure in the low-pressure torch is 1.7 of oxygen to 1 of acetylene. More oxygen than this will cause an oxidizing flame and less will cause a carbonizing flame. With either kind, good welds are not possible to make. It is, therefore, necessary that the mixture be kept permanent.

As the gases are used at low pressure, the speed of the mixture issuing from the nozzle is but little above the speed of propagation of the flame, and hence this flashes back occasionally. The mechanism in the torch to prevent this flame traveling back past the torch has overcome this difficulty, however, and these torches are perfectly safe to use.

Medium-pressure Torch

The high-pressure torch had many faults and, to overcome these, a medium-pressure torch was developed. This has almost universally displaced the high-pressure torch, and in this country the medium-pressure is called the high-pressure torch.

In this medium-pressure torch, both the acetylene and the oxygen are used under pressure, the acetylene being taken from the storage tank, at from 2 to 3 pounds pressure per square inch, while the oxygen for welding operations is taken from its receptacle at a pressure of about 15 pounds. When cutting, however, an extra jet of oxygen is used in the torch at a much higher pressure. For very thick metal, something like 300 pounds might be required, but never less than 50 pounds is needed, even with very thin metals.

The mixture is then regulated by small holes that allow the two gases to flow into a mixing chamber and a constant proportion of each gas is quite easily maintained. By controlling the pressure at which the gases flow into the torch, the volume of each is easily controlled. In this medium-pressure torch it is 1.3 of oxygen and 1 of acetylene.

The higher pressure at which the gases are used keeps the speed of the gases well above the propagation of the flame, and hence flash backs are not as frequent as with the low-pressure torch; but if the torch becomes too hot, they are liable to occur, or the flame may be deflected back into it by touching the metal being welded, or the orifice becoming clogged with pieces of metal, dirt, etc.

Acetylene that has been dissolved can be used with this torch as successfully as that coming from the generator. Where desired, therefore, both gases can be used from storage tanks, and do away with the trouble of keeping generators charged and cleaned.

Causes of Flash Backs

If the gases travel through the torch at their normal speed without any retardation, there is no danger of a back flash that might explode the gases in the storage tank. If from the several reasons previously mentioned or from others, the gas speed is retarded, the speed of propagation of the flame is liable to become greater than the speed of the gas flowing from the torch. This would cause the flame to travel back into the supply of gas in the storage tank and draw enough oxygen with it to start in motion the atoms of oxygen and carbon at a speed that would cause an explosion.

The pressures of the gases in the storage tanks are also liable to be reduced to a point that would not cause them to flow to the pipes and torch as fast as the speed of propagation of the flame and thus cause an explosion. Carbonaceous material might also clog the orifice. Other causes of back flash might be given, but these are enough to show the necessity of having something in the torch to prevent the back flash, that is, something that will destroy the flame and halt its further travel backward. Only a few reckless ones have tried to abolish its use, and the National Board of Fire Underwriters has inserted a clause in its new rules that makes compulsory the use of a flash-back preventer in welding torches using oxygen and acetylene.

Flash-back Preventers

The flash-back preventer of Le Simplex torch is an automatic safety valve that closes the instant there is any back pressure.

The Society B. R. G., of France, caused the acetylene to flow through a chamber filled with porous earth before it mixed with the oxygen, near the nozzle of the torch, and thus prevented a flash back.

In the Fouche torch the acetylene passes through two fine tubes that are coiled several times to prevent the flash back,

and in addition to this a safety valve is inserted back of the coil.

The Cyclop torch has a specially arranged chamber for stopping the flash back of the flame, and in addition to this the oxygen is coiled around the head of the apparatus to slightly preheat the gas and thus maintain a more constant proportion of acetylene and oxygen gas, in the mixture leaving the nozzle.

In the Kimball, or Oxy-Carbide Company's, torch 16 small tubes are inserted in a ⅜-inch tube, thus making the spaces so small, through and around the small tubes, that the flame will not travel back their entire length.

Le Chatelier's torch had inserted in it a wire screen, through which the acetylene passed before mixing with the oxygen, to prevent flash back.

The torch recently designed by W. I. Reich contains an automatic valve for preventing the back flash.

The torch of the Harris Calorific Company prevents flash back by causing the acetylene to travel through a series of fine longitudinal slots that are cut with considerable depth in both the blow pipe and the handle.

Exceptions

Acetylene has been used with other gases, such as illuminating and natural gas, for welding and cutting certain kinds of metals. Oxygen, likewise, has been used very successfully with hydrogen and liquid gas, and with gases made from gasolene, benzine, naphtha, alcohol, etc. These combinations, however, do not have nearly as high a degree of explosiveness as the oxygen and acetylene combination. Therefore, no flash-back preventative is used on the torches, or at least it is very seldom seen, as this is taken care of in other ways.

Where oxygen and acetylene are mixed, however, and used for welding and cutting metals, a flash-back preventative is always used, as this is liable to occur at any time. If the flame is prevented from traveling back into the storage tank, by a flash-back preventer on the said tank, the one in the torch would at least prevent the burning and tearing up of the hose connecting the torch to the storage tank, and it would also stop the flame in case the flash-back preventer on the tank got out of order.

Effect on the Weld

The quality of the weld made with these torches depends entirely upon the composition of the gas leaving the nozzle and the regulation of the flame; hence, it is necessary to have reducing valves between the storage tanks and the torch.

The one on the oxygen tank should control the oxygen so it will enter the torch at from 15 to 40 pounds pressure per square inch, according to the thickness of metal that is to be welded, and when cutting metals not less than 50 pounds pressure should be used.

The reducing valve on the acetylene tank should be so made as to allow the pressure to be adjusted anywhere between 2 to 25 pounds per square inch, according to the nature of the work.

The oxygen should arrive at the torch in a constant predetermined pressure for a given thickness of metal; but the other gas may vary, as by varying the speed of the combustible gas, the flame can be easily regulated so as to produce a flame that is between an oxidizing and a carbonizing one.

Conditions Produced

A single flame incloses solid particles in suspension, the number of which is in proportion to the light that it gives. Hydrogen, or more often carbides of hydrogen, are the combustible gases used in welding and cutting metals. The flame of hydrogen is pale and it, being a simple gas, does not hold in suspension solid particles. Carbides of hydrogen, however, such as illuminating gas, acetylene, etc., decompose at the temperature of the flame into hydrogen and particles of carbon in suspension, the hydrogen burning easily and liberating much heat.

From this three conditions arise, namely:

First. If the quantity of oxygen is too small to burn both the hydrogen and the carbon, as in a case of acetylene burning in the air, the hydrogen will burn first, and the carbon heat to a white red and produce a flame that is very brilliant.

Second. If the oxygen is present in greater quantity than is required to burn up all of the hydrogen and all of the carbon, the products of combustion will be oxygen in excess, water vapor and carbonic acid gas. This flame will be pale and oxidizing.

Third. If the volume of oxygen is just enough to burn all the hydrogen and all the carbon, the products of combustion will be oxide of carbon, water vapor and carbonic acid gas. The flame will be pale, owing to its not holding any particles in suspension, and a reducing one.

Effect of Conditions

In the first case there is a loss of heat due to the fact that the carbon, which liberates much heat in burning, is not all burned but part of it is held in suspension in the flame. The carbon in suspension dissolves into iron, at a red heat, and forms graphitic carbon. It thus causes a lessening of the heat, as well as the formation of cast iron in the weld. If, therefore, steel is being welded, the joint is formed with a graphitic iron and thus a weld is made whose efficiency is very low.

In the second case, all of the carbon in suspension is burned and some of the oxygen is left over. The carbonic acid gas and water vapor formed by combustion are nonreducing substances, and hence the flame is nonreducing. The oxygen in excess, therefore, attacks steel or iron when heating it up to the fusion point for welding and oxidizing it. The oxide thus formed cannot be reduced by this nonreducing flame and, therefore, will enter the weld. The oxide does not enter into combination, or form a solid solution with the iron, and therefore a weak, brittle metal is produced.

In the third case there is just enough oxygen to burn all of the carbon in suspension but not enough to transform this carbon into carbonic acid gas; therefore, as it comes out of the nozzle it gives off oxide of carbon and water vapor. The oxide of carbon is combustible and burns as soon as it comes in contact with oxygen. It is consequently a powerful reducer. In fact, it is the principal reducing agent for oxide of iron when smelting ore in the blast furnace. The reducing flame, surrounding the cone of the welding-torch flame, aided by the high temperature, will change any of the oxide of iron that may form in the vicinity of the nozzle of the torch and return it to the metallic condition. Thus with a flame that is well adjusted a weld can be formed, by fusion, that is free from both carbon and metallic oxide, and an efficiency of 90 per cent. is often obtained in the weld.

With the oxy-hydrogen process of welding, however, there is no fear of carbon, and oxidization is the only thing to prevent. An excess of hydrogen is all that is necessary to prevent this; but if the excess is too great, it will cool the flame.

If we start with an illuminating flame, with the carbides of hydrogen, as in the first case, and decrease the combustible gas slowly, the flame will decrease in brilliancy and suddenly become pale. This is the exact point of the disappearance of the excess carbon. Illuminating gas contains about 50 per cent. of hydrogen and but small quantities of carbide rich in carbon, such as ethylene and acetylene. The decrease in the flame, from brilliant to pale, is therefore less sharp, but it is possible to regulate the feed of the gas by considering the two parts of the flame.

Adjusting Flame

The flame produced for welding is elongated and divided into two parts, one of which forms a very brilliant cone, or point, close to the nozzle, that is from ¼ to ½ inch long. Covering this is an elliptical-shaped flame, pointed at both ends, that has a slight red tint, but is almost colorless.

With the oxygen and hydrogen flame the cone is hardly visible and is very pale, thus making regulation by eye quite difficult; but at a certain moment the cone assumes a rose-violet coloration and this indicates the correct quantity of each gas in the mixture. With the oxy-acetylene flame, however, the contrast between the brilliant white cone and the almost colorless covering flame is so great that it is easily regulated by sight.

Confessions of a Professor

By Entropy

Dealing with the questions of actually earning the salary; of nerve and bluff; in a humorous manner which may carry several grains of truth.

Any man who bears the title of professor can get commiseration in plenty from all except his creditors if he but alludes to the underpaid state of the profession. Statistics show—well, they show whatever the statistician starts out to show, but they are popularly supposed to show that the teaching profession is underpaid. I have heard it said that the average brick layer, if he does not go on too many drunks in the year, gets more pay for his services than the average college professor. I have no doubt it is true. A brick layer is a most skilful man. He can pick up a brick with one hand, dip a heaping tablespoonful of mortar with the other and lay the brick in a nice moist bed quicker than I can write it, and at the same time keep up a running fire of profanity that alone would tax a college professor. I tried my hand at it once not in a spirit of rivalry but in a spirit of economy. I had 200 bricks and I had two weeks' time. It took the two weeks to place the 200 bricks so they did not fall down; at the same time I also nearly lost my wife's affections. Even today when she looks at the job I did, she says she envies the professional brick layer for his easy flow of language.

To get back to the subject of remuneration, I want to say that I have at least the average man's nerve, but even with that it is fortunate that the treasurer mails my salary check to me at regular intervals rather than asking me to call around and draw it in person. When I get the check it seems so like robbing the children's bank that if it were not that it is as easy to deposit it in the bank as to put a penny in the contribution box at church I doubt if I would always have the nerve to do it.

My wife often asks me how I earn my money and I have to admit to her that it is just clear bluff. I bluff the president and I bluff the boys and the public. I go into my classes and I fill up time lecturing on things that I know the boys will not once in a thousand chances ever have occasion to use. I tell them things and insist on their learning things that I seriously doubt and that I know that other and more able men also doubt. I have to do it. We all do it. We have to pad out our subjects or we could not run a four years' course. We have to teach things as positive facts when we realize that they are only conjectures because we know by experience that boys and young men will not pay attention to conjectures, but that they will absorb truths and untruths alike if presented as concrete facts.

I teach 18 hours per week. I tell the president I cannot handle more because of the time I have to spend in preparation and research and in correcting papers. He swallows it because he was a professor and did the same thing. He only asks me to do more so that he can pass along my reply to the trustees. You see, we were all bluffing. As for preparation, of course it is absurb. Here I have been teaching the same thing in the same way for the past five years. "Time for preparation!" Why, I could wake up in the middle of the night and start off a recitation from any part of the course without a book or a note or any other preparation. I ought to brace up and change textbooks and rustle up a little modern padding for my course. I think now I will, next year. To be sure my work is mostly mathematics, and all that these boys can absorb has not changed in 3000 years, but I really ought to strengthen my bluff by adding a little of this modern stuff, if there is any that is not bluff just like the rest of my work.

And the time correcting papers! Worse yet; whenever I can I chuck the stuff in the waste basket. Other times I read it, snatches here and there. I see if the answers to problems are right and if there is the proper amount of work preceding the answer. I seldom look to see if it is the work that goes with that particular answer or not.

The first of each term we try to catch a few fellows cribbing their work and make examples of them, just as my father used to shoot a crow and hang it up in the cornfield. We rely on that to scare the fellows into making their bluff as complete as possible.

As to pay. Why do you suppose we don't all leave the profession and get better paid jobs? If the pay is so poor why don't we get more? Just because we are either lazy or incompetent. And then the pay is good. I get close to two dollars an hour for the actual time that I really spend working for the college. Most of the rest of my time I waste or fritter away. Time hangs heavy on our hands and we gather in each others' offices (holding conferences!) and kill all of it we can. Do you wonder that we do not go out and get useful jobs? Who would pay me $2 a day to do useful work, say turning pulleys or cutting lead screws? Your advertisers need not answer in a chorus, because I prefer to draw the $2 an hour so long as I can make the bluff go.

When the best and the worst of the teaching profession is said, it only remains to say that it is a horrible example of what may easily happen in any profession or any trade. A few weeks ago I heard a labor leader in Boston, who said that he was hoping to see the time when everybody would work five hours per day and get five dollars for doing it. That was his idea of the ideal job. It represents roughly the condition of the teaching business. When men get so far that they get their five dollars a day they will find that they need jobs that occupy them more than five hours per day; otherwise they will spend the balance of their time wondering how five dollars can be made to cover the necessities that go with a five-dollar job. For it is a fact that I believe nearly all the victims will agree on, that $1500 a year is the poorest, cheapest, measliest salary there is. A man on $1000 is not expected by his neighbor to spend much, but when the neighborhood finds a man is getting $1500 a year, their demands on him cover $2000 out of sight. And for just that reason a college professor is poor, just because the demands of society on him are out of proportion to his income and his ability, for it must be conceded that when a $1500 or $2000 professor is fitting boys for $3000 and $4000 jobs that there must be something lacking or he would go out and get the jobs himself.

Appearance of Solders

An exhaustive paper on the subject of solders, read before the Institute of Metals at Manchester, England, thus summarizes the effect of various ingredients on their surface appearance.

Solder containing 2 per cent. of antimony gives, under proper conditions of casting, a surface which is bright, clear, smooth and superior in appearance to that of the alloy consisting wholly of lead and tin in equal proportions.

Solders containing more than 2 per cent. of antimony give surfaces which are either rough, spotty, frosty or pimply, but the extent to which these defects are present does not increase in proportion to the amount of antimony added.

Solders containing small quantities of copper give good surfaces, but with a tendency to blister, while larger quantities give dull, flat, crystalline surfaces.

Solders containing small quantities of silver have a peculiar white crystalline appearance on the surface.

Zinc is most detrimental to solder.

Some Railroad Shop Appliances

By E. H. Deidrick*

The halftones, Figs. 1 and 2, and the drawing Fig. 3 illustrates a pneumatic pit jack which was devised to reduce the cost and expedite the application of shoes, wedges and stayplates, and, in practice it eliminates the services of the "man with the bar" on the floor. In these days of heavily counterbalanced drivers it is often necessary to slip the wheel around to use the bar through the wheel at all, in which case the undertaking calls for the application of an ordinary slow movement jack and plank, or some heavy lifting by the men down in the pit.

This tool has successfully produced the results desired, enabling two men to perform the work formerly requiring three, and in quick time, which is an important item in a fifty-two pit shop.

It is, withal, an appreciated tool in the "shoe and wedge" gangs, which fact, in a great many instances, materially prolongs a tool's period of usefulness.

*Tool department foreman, Lehigh Valley Railroad System Shops, Sayre, Penn.

Device for Twisting Forged Drills

The accumulation of stubs of forged

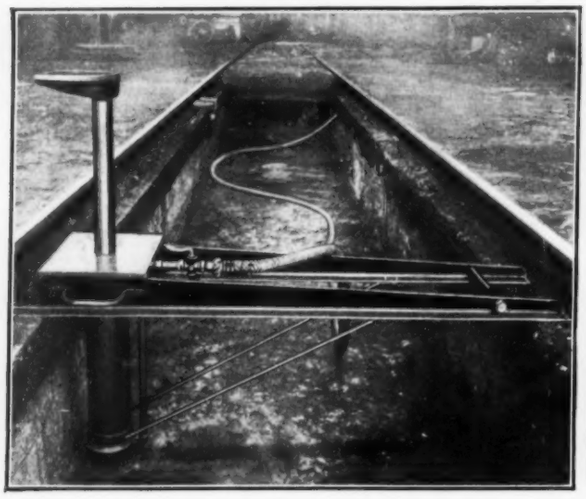


Fig. 1

A Pneumatic Pit Jack

Fig. 2

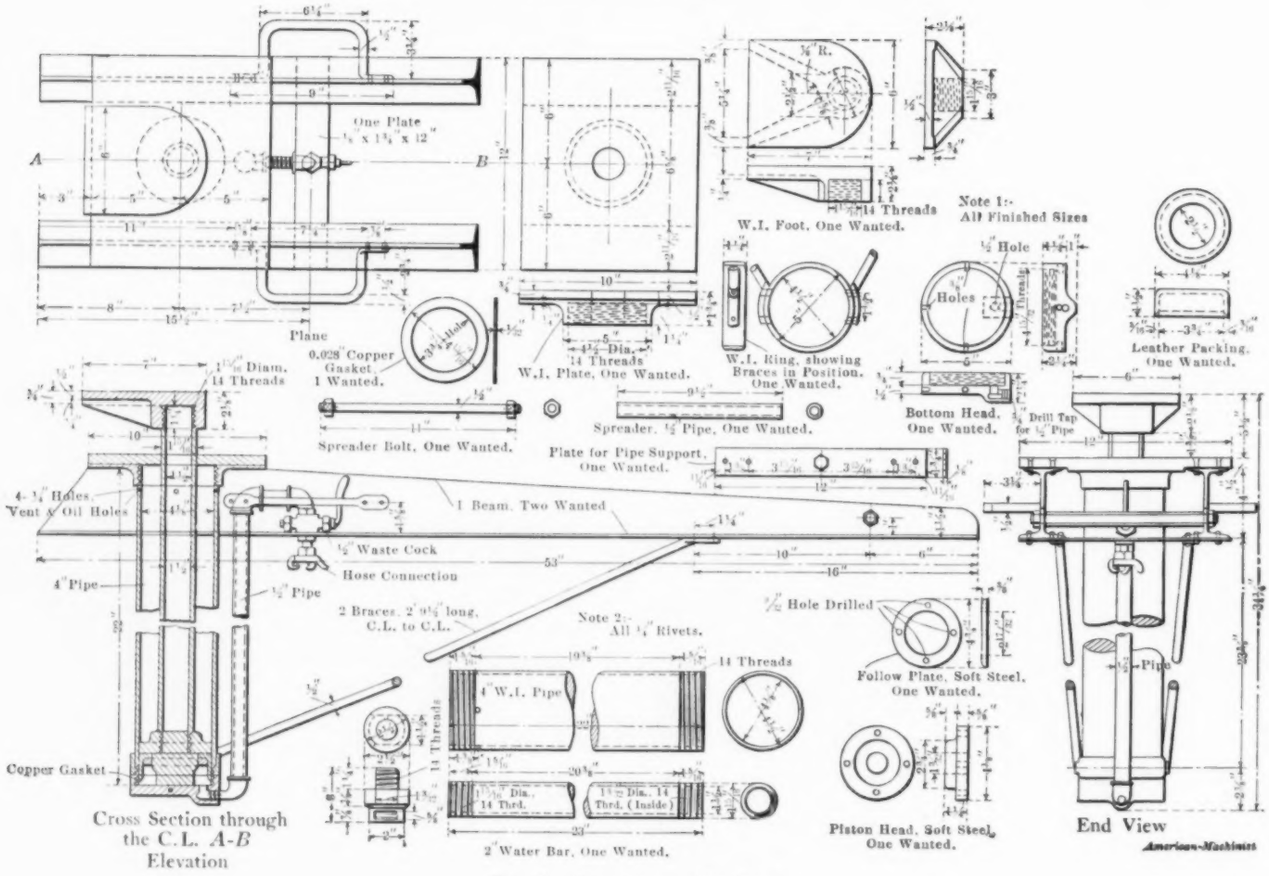

One Plate ⅜" x 1¾" x 12"
Plane
0.028" Copper Gasket, 1 Wanted.
W.I. Plate, One Wanted.
W.I. Foot, One Wanted.
W.I. Ring, showing Braces in Position. One Wanted.
Note 1:- All Finished Sizes
Leather Packing, One Wanted.
Bottom Head, One Wanted.
Spreader Bolt, One Wanted.
Spreader, ½" Pipe, One Wanted.
Plate for Pipe Support, One Wanted.
I Beam, Two Wanted
4-¾" Holes, Vent & Oil Holes
½" Waste Cock
Hose Connection
4" Pipe
½" Pipe
2 Braces, 2' 9½" long, C.L. to C.L.
Note 2:- All ¼" Rivets.
½" Hole Drilled
Follow Plate, Soft Steel, One Wanted.
Piston Head, Soft Steel, One Wanted.
Copper Gasket
4" W.I. Pipe
2' Water Bar, One Wanted.
Cross Section through the C.L. A-B
Elevation
End View
American Machinist

Fig. 3. Pneumatic Pit Jack

tools in a corner near the toolsmith's fire is a proposition that will sometimes make one wish the fellows would "throw it in the canal" instead of returning the stub to the tool window for a possible redressing. The inexpensive device shown in Figs. 4 and 5 has reduced our scrap pile to a minimum and in its stead we have a stock of high-speed steel drills that are giving results.

If we had had facilities for easily obtaining this spiral nut in cast iron with the hole cored, that method would prob-

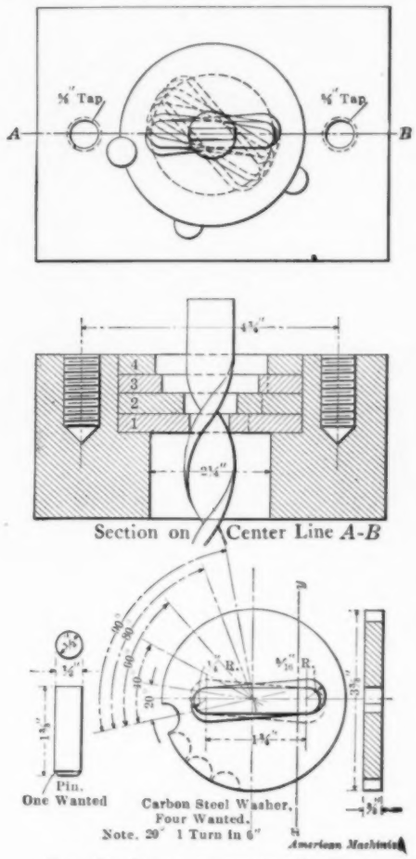


FIG. 5. DRILL-TWISTING DEVICE

ably have been used, but necessity resulted in an adjustable nut, shown in Fig. 5, made up of a series of disks that will produce as many degrees of spiral as there is room for dowel-pin holes around the periphery of the disks, one turn in three inches being easily obtained. Under the steam hammer where the blow is delivered square, a standard length of twist is readily obtained at one heat. A copper-faced sledge was provided for this job after our toolsmith had a flying sliver from the shank end of a drill removed from his hand. The ⅝-inch tapped holes shown in Fig. 5 are for clamping the disks when trying out for any twist desired, preparatory to drilling for the dowel, which is a loose fit, as are also the disks in the block. The disks are then hardened.

Fig. 4 shows partially finished taper-shank drills ¾ to 15/16 inch and rough forgings for 1¼-inch drills.

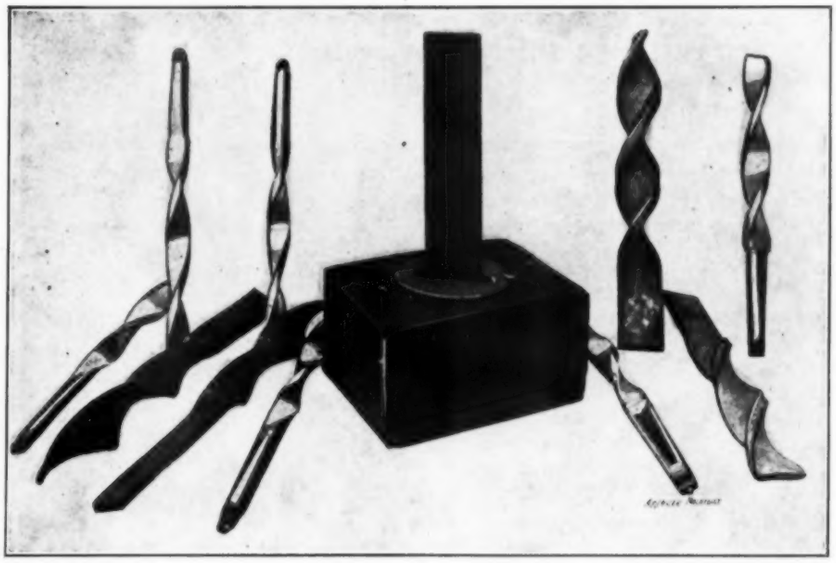


FIG. 4. DEVICE FOR TWISTING FORGED DRILLS

COPPER GASKETS

Our copper gaskets for steam and air connections are produced as shown by Fig. 6, in a way which explains itself. No expense was necessary for even a makeshift power press. The punch holder shown accommodates the several punch plates for the various sizes of gaskets used and the thick stripper plate with the stroke of the slotter short gives

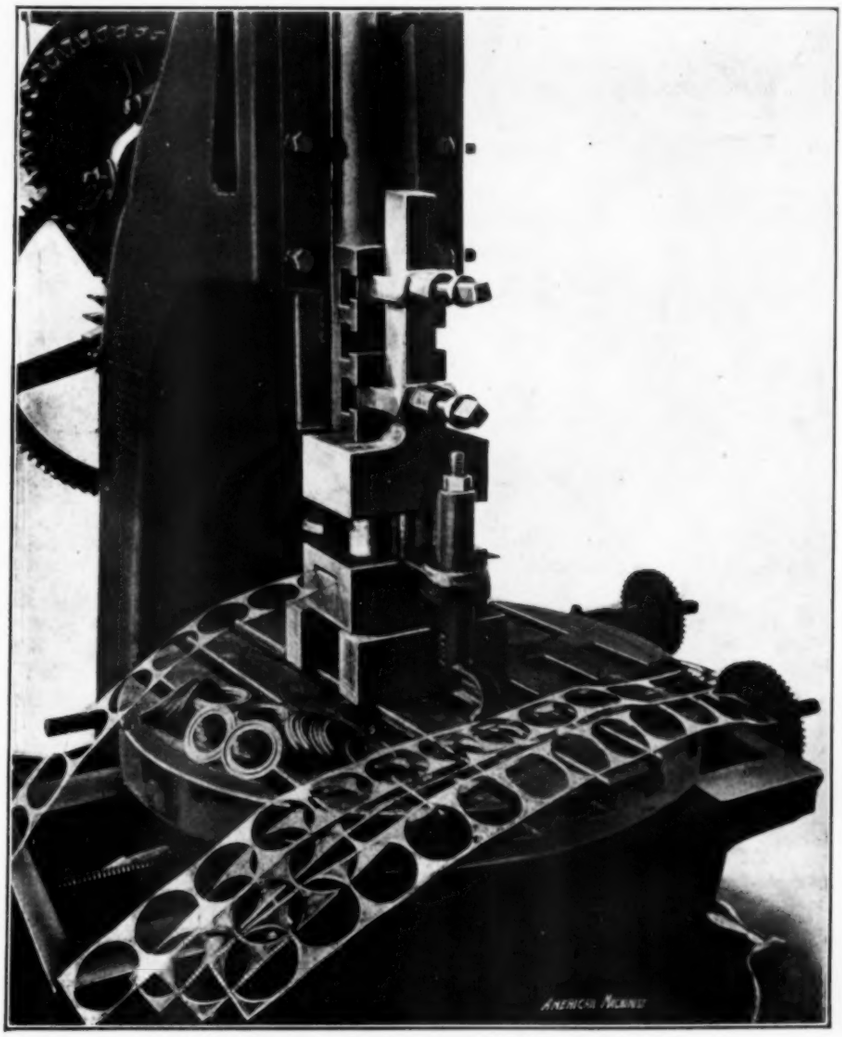


FIG. 6. MAKING COPPER GASKETS IN THE SLOTTER

the advantage of subpress construction when setting up, as the punches do not have the stripper, also the apprentice boy can't get his fingers where they should not be when in operation. The die is "follow" style and produces a finished gasket at each stroke.

This job keeps the tool-room slotter busy and a first-class gasket is produced at low cost. While the punch and die, as illustrated by the engraving, are of ordinary construction, their application to the slotter cleaned the job up quick when we were "long" on gaskets and "short" on power punches.

A Plant With 68,905 Employees

Editorial Correspondence

Notes from the famous Krupp works at Essen, which include iron and coal mines, blast furnaces, foundries, machine shops and everything up to proving grounds for guns.

How the workers are housed, fed and taken care of when they are disabled.

It requires 140 *general supply stores, restaurants, coffee stalls, etc., for this city of workers.*

The name Essen at once calls to mind the great works of Krupp, the largest industrial enterprise in the world. On May 1, of this year, the total number of employees of the Friedrich Krupp Aktiengesellschaft was 68,905, of whom 6840, or practically 10 per cent., were officials.

This army of employees was divided among the various departments as follows: Cast-steel works and ordnance proving grounds, 37,848; collieries, 10,035; iron-ore mines, 4763; iron works on the middle Rhine, 1075; shipping agency at Rotterdam, 49; Friedrich-Alfred Hütte (blast furnaces, steel works and structural steel shops), 5665; steel works, Annen, 1027; Grusonwerk (armor and ordnance works, foundries and chilled-iron castings, steel castings and the like, and shops for producing forgings, railway material, cranes and hoisting machinery, hydraulic presses, rolling-mill plants and crushing and ore-dressing plants), 3939; Germaniawerpt (shipyards), 4504.

What a growth and expansion this has been from the beginning made in 1811 by Friedrich Krupp in founding a firm to manufacture crucible steel after its importation from England had been restricted by Napoleon! Although the firm was founded in 1811, it was not until October, 1816, that Krupp met with his first success in making crucible steel. From that beginning has grown the mighty works that are now owned solely by his great-granddaughter.

The financial organization is a joint stock company having a capital of 180,000,000 marks ($45,000,000) owned by Mrs. Gustav Krupp von Bohlen und Halbach (*née* Miss Bertha Krupp) and managed by a board of 10 directors.

Industrial Betterment Work

Aside from its extent and the multitude of its manufactures the firm of Krupp is justly famous for its work to aid its workmen to gain better living conditions—work that we somewhat inaccurately term "industrial betterment work." It is this feature that we will briefly outline here.

This important work had its beginning in 1853, with the founding of a sick fund to award relief in cases of sickness and death. Three years later this fund was reorganized, as fund for workmen's pensions was added, and barracks erected to lodge and board 200 workingmen.

In 1858 a bakery was established, and this has grown until today it is housed in a large building of its own, where 300 sacks of flour, weighing 100 kilograms (220 pounds) each are made into bread each day. Twenty kinds of bread are produced and sold to the employees of Krupp at a price slightly lower than that charged by city bakeries for a corresponding product. The writer can testify to the excellence of the zweiback from a personal investigation. Machinery is used throughout for all possible operations and the building contains a complete milling plant where considerable wheat is milled. Needless to say the cleanliness of the place was all that one could ask for; in fact, it was remarkable.

In 1861 the first foremen's dwellings were erected, and in 1863 began the erection of workingmen's dwellings at Alt-Westend, with about 160 homes.

The next two years saw an extension of the workmen's boarding houses to accommodate 550 men. Today there are two of these workmen's homes, having accommodations for some 1150 men. In the older building the charge is 80 pfennigs (19 cents) per day for lodging and board, or 65 pfennigs (15½ cents) for lodging and the midday meal. In the newer building the charge is 90 pfennigs (21½ cents) per day.

Reading, Smoking and Dining Rooms

Each building has reading rooms, smoking rooms, writing rooms, bath rooms, etc. Tickets are sold for baths at the rate of 12 shower baths for one mark (24 cents), or six tub baths for one mark.

In a large dining hall some 3000 men dine each noon. The price of the dinner is 35 pfennigs (6 cents). A meat course is furnished, together with a heavy soup. The meat is served in portions, while the soup is served so that a man can eat as much or little as he will. The writer was served one of these dinners and found it very enjoyable.

Over 8600 Dwellings

In 1870 workmen's colonies were started on a large scale, and by the end of 1872 five sections had, respectively, 70, 100, 160, 780 and 1300 dwellings. At the present time the total number of these dwellings is some 8600.

In 1874 the coöperative stores that had been purchased in 1868 were enlarged and extended. The two following years saw the inauguration of industrial schools for the wives and daughters of employees and for school girls.

The year 1877 saw the foundation of the Life Insurance Society for Employees of the firm of Friedrich Krupp, originally endowed with 50,000 marks ($12,500). During the following decade the work already started was continued. In 1889 a loan fund of 500,000 marks ($125,000) was set aside to aid workmen in acquiring their own homes.

Looking After the Disabled Workmen

In 1892 a grant of 500,000 marks ($125,000) was made for the erection of a colony, "Altenhof" for disabled and pensioned workmen. In 1897 a fund of 1,000,000 marks ($250,000) was set aside for the Aged and Disabled Workmen's Fund to supplement the aid given through the other organizations.

The year 1900 saw the beginning of the savings bank for the workmen of the cast-steel works of Essen.

The work of all these activities has gone steady forward with ever enlarging usefulness. The supply stores for general merchandise now number some 87; stores for rough supplies, as coal, straw, potatoes, etc., 28; restaurants, 12; beer stalls, 10; coffee stalls, 3.

This very meager outline of the rise and development of these institutions at the Krupp works shows how early they were started in the history of the company, and how they have grown and extended. The aggregate payments of the firm in insurance, stipends and otherwise now amounts to upward of 9,000,000 marks ($2,250,000) annually.

Principles of Running Balance

A General Discussion

Several points of view which include the spring of the shaft being balanced.

How the Norton machine indicates the slightest variation of balance and secures practically perfect results.

The article on page 241 on the "Principles of Running Balance," by Mr. Alford, is one of the most useful contributions to shop science that has appeared recently. I feel, however, that if his conclusions had been carried a step further, they would appear clearer to the non-technical mind.

The condition for exact running balance is that in every plane perpendicular to the axis of rotation the weights shall be in standing balance.

Let us see if this applies. The "porcupine," Fig. 1, is obviously in both standing and running balance if made right and the central shaft and pins are homogeneous. Fig. 3 is in standing balance, but the material in the planes through the two end sets of quills is *not* in standing balance; therefore, the porcupine as a whole is out of running balance. In Fig. 5 this has been brought back into running balance by making the standing balance of the two sets of end quills balance. The same thing is done in Figs. 6 and 7.

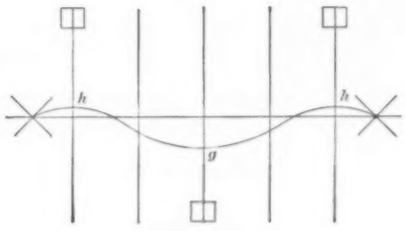


FIG. 8 *a*

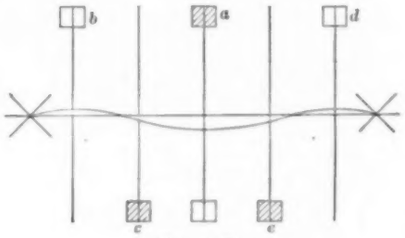


FIG. 9 *a*

American Machinist

THE SPRING OF A SHAFT IN MOTION

When we come to Fig. 8 (reproduced in Fig. 8a herewith), however, we see that there are three planes which are each out of standing balance, the two end ones and the middle one. In running the porcupine in this state the centrifugal force of the middle weight will have a great deal more tendency to spring the shaft than the other two. In Fig. 9 (reproduced in 9a), this springing tendency is overcome by the weight *a* on the opposite quill, while the end weights *b*, *c*, *d* and *e* are each in a separate plane and therefore there is not a full and true running balance. Now let us see why there is a practical balance, as shown by the Norton machine.

Fig. 8a shows (exaggerated, of course) the curve taken by the axis of the porcupine when running at high speed. The deflection at *g* is much greater than at *h h;* consequently the center of mass of the body (at high speed) does not coincide with the axis of rotation.

In Fig. 9a, weight *a* counteracts this tendency of the original middle weight, but weights *c* and *e* have, from their position, a slightly greater tendency to cause deflection than *b* and *a*. Evidently, however, this tendency is not greater than the sensitiveness of the machine. The machine shows a running balance, but if a pointer were attached at the center of the shaft it probably would not.

Fig. 10 and 11 show a true balance on the machine for the same reason, though with a pointer or indicator on the middle of its length it would probably run out still more in both cases, the preponderance of weight being on the lower side as drawn on each of the three middle quills.

In Figs. 12 and 13 this preponderance is so much greater as to readily account for the author's difficulty in making his mathematics agree. The axis of the test piece undoubtedly sprang into the shape shown in Fig. 8a sufficiently to necessitate the moving of the weights from their calculated position.

None of these cases, Figs. 9 to 13, inclusive, are absolutely in running balance in that they all have stresses in the shaft due to unbalanced centrifugal forces. No matter how large or stiff the shaft under test may be, there will be some deflection no matter how slight the unbalanced force. The Norton machine only detects the lack of balance when the deflection is large or when the unbalanced centrifugal forces are not equally balanced on the two bearings. For example, in Fig. 9a, *c* and *e* are equally distant from the bearings. If *c* were left where it is shown and *e* were placed opposite *b*, the machine would not show a balance; nor would it probably show a balance if *e* were moved opposite *d*, though that would depend on the sensitiveness of the machine.

In the case of a crank shaft it does not seem to me that a two-bearing machine should be used to test a four- or five-bearing shaft. Of course, crank shafts cannot be made stiff enough to make them so free from deflection as the porcupine. Unless the portion between each pair of bearings is in balance by itself or is balanced by the part between the next pair, there is bound to be an unnecessary pressure brought on the bearings themselves, due to unbalanced centrifugal forces.

In any case where an apparent balance is obtained in violation of the rule given at the beginning of this article there is likely to be a variation in the balance as shown by the machine at various speeds, for the centrifugal force varies as the square of the number of revolutions per minute while the deflection under stress varies with the weight or force applied. It might easily happen that a crank shaft might be out of balance in one direction at low speeds and yet deflect sufficiently under higher speeds to show (and to be) out of balance in the opposite way.

E. H. FISH.

Mr. Fish ignores the fact that the Norton machine *does provide* for indicating at *any number of points;* it is not limited to two points. Also, that the *scriber* detects the slightest deflection, even when the pendulum indicator does not show any movement.

He forgets that while there are forces at work in revolving bodies it does not necessarily follow that they have any effect upon the smoothness of running of the body in practice.

The Norton machine is intended, not to *discuss technically certain "forces,"* but to locate such errors from running balance as will enable a *workman* to understand what to do to cause the body to revolve smoothly and quietly in its place in a machine, and that is exactly what the "porcupine" did in all cases where a running balance was shown.

There may be a difference between a "practical" running balance and a "technical" running balance. If there is, we in practical life do not care; all we want is to understand how to secure the smooth running of our revolving bodies, and this machine enables us to understand it, while the technical explanations never have.

C. H. NORTON.

The description of the machine gave the impression that we depend on the needles (eyesight) to detect balance. If

he had explained the use of the pencil points, Mr. Fish would have understood that even when the needles are *comparatively* still, the pencil will show error.

When the needles are still, however, we call the balance "good enough," just as we call a diameter correct when the micrometer says so, although we all know that the measuring machine might prove that there was an error of 0.0000000000001 inch.

J. C. SPENCE.

[In all previous discussions of this subject the revolving body has been assumed to be rigid, the spring of the shaft indicating a new viewpoint which may be fairly called a discovery due to the use of the Norton machine.

While this spring must theoretically be present in the cases referred to, it seems to us a superrefinement to consider it in most cases. It does develop in automobile crank shafts, as the machine has shown, and for the testing of which it was originally designed. Such shafts are, however, springy, flexible things, while in them the condition laid down in Mr. Fish's second paragraph cannot be realized exactly or even approximately except by the addition of balancing cheeks opposite the crank throws, which, we imagine, few automobile designers or builders would seriously consider. The lesson taught by the test of such cranks is that they should have at least a center bearing and preferably a bearing wherever a place can be found for it.

The Norton machine provides a means of putting parts in perfect running balance provided their form is maintained, but in many cases, of which automobile crank shafts are one, this can only be secured by adequate bearings, and even without this maintenance of form it puts them in running balance as that term has always been understood.—ED.]

Economical Size of Air Hose

By R. D. Gatewood*

Determining the best size of air hose for pneumatic tools used in a shipbuilding plant.

Finding the smallest size that can be used economically in 50-foot lengths.

*Assistant naval constructor, United States Navy.

After the specifications described in a previous article, page 393, had been gotten up, an investigation was made to determine the most suitable size of air hose and leaders for use in connection with work with the ordinary pneumatic tools used in a shipbuilding plant and hoists up to three tons. It was found that there were in use at that time about nine different sizes of hose between ⅜ inch and 1¼ inch. This hose was not carried in any one department, but under the various departments then existing in the yard† so that in the case of an urgent call for hose by one department, it was necessary to provide in addition to the hose all the fittings, manifolds, etc., that belonged to that particular size of hose, as, in all probability, it would not fit the manifolds and fittings used by the department requesting the hose. It was at once apparent that a number of advantages would accrue from the use of as few sizes as possible, among the most marked of these being the following:

1. Many complications and much confusion of hose and fittings would be done away with, resulting in a considerable saving of time in picking out hose and fittings.

2. A considerable saving in cost could be effected by buying large quantities of a certain single size instead of smaller quantities of a number of varying sizes.

3. It was also believed that the ¾-inch hose, which was then in common use on all hammers, drills, air hoists, etc., was somewhat too large and that a smaller size could be used with equal satisfaction at a considerable reduction in cost.

Tests were first made on a pneumatic drill running light with a 50-foot length of ⅝-inch hose and a 10-foot leader of 7/16-inch hose. The full line pressure of 80 pounds was allowed to pass through the drill; gages were placed in the line where the air was taken off and at the drill immediately before entering the machine. The revolutions per minute of the drill were taken with a tachometer for various pressures, and it was found that until the line pressure was reduced to 45 pounds, giving a corresponding pressure at the machine of 40 pounds, there was not a perceptible diminution in the number of revolutions per minute of the machine, which remained at 525 for all pressures at the machine between 80 and 40 pounds.

From the above it is seen that in order to determine whether or not the hose supplied sufficient air for the drill under working conditions, some form of work must be given the drill to do, and it was first suggested that the drill be used on an actual drilling test. This idea was abandoned for the following reasons: 1. it would be difficult to give the drill a constant feed; 2. difficult to keep the machine pressure constant due to irregularity of feed, dulling of drill, and the nonhomogeneity of material drilled; and 3. difficult to bring the drill to the same degree of sharpness after each test, and impossible to allow for the dulling of the drill during the tests at different speeds.

Hose.								
Size, Inches.	Length, Feet.	Leader, ⅞-inch.	Line Pressure, Pounds.	Machine Pressure, Pounds.	Actual Fulcrum of Lever, Inches.	Load on Break, Pounds.	Revolutions per Minute.	Horsepower.
¾	25	...	80	80	18	10	179	0.51
¾	50	...	80	79	18	10	179	0.51
¾	25	...	80	79	18	10	179	0.51
¾	50	...	80	79	18	10	179	0.51
¾	50	10′	80	76	18	10	172	0.47
¾	50	10′	80	75	18	10	164	0.45

TABLE 1. TEST OF A PNEUMATIC DRILL.

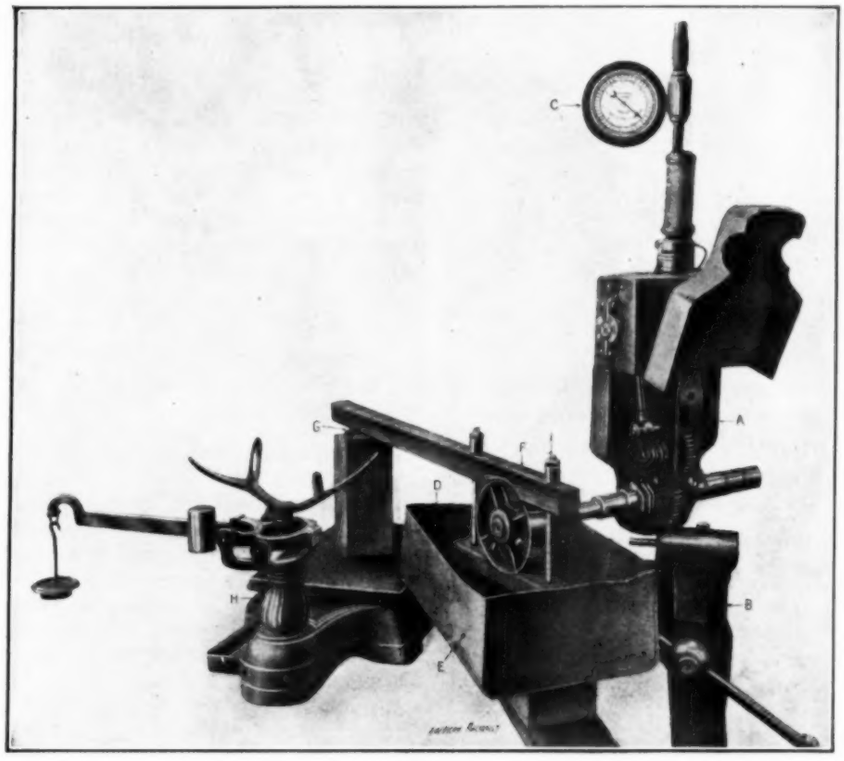
Hose.								
Size, Inches.	Length, Feet.	Leader, ⅞-inch. Feet.	Line Pressure, Pounds.	Machine Pressure, Pounds.	Fulcrum of Lever, Inches.	Scale Reading, Pounds.	Revolutions per Minute.	Horsepower.
¾	50		80	77	18	10	15	
¾	50		80	78	18	20	93	0.53
¾	50		80	79	18	30	75	0.64
¾	50		80	79	18	35	66	0.66
¾	50	10	80	69½	18	10	112	
¾	50	10	80	70	18	20	90	0.51
¾	50	10	80	75	18	30	72	0.62
¾	50	10	80	75	18	35	62	0.62
¾	50	10	80	70	18	10	115	
¾	50	10	80	71	18	20	91	0.52
¾	50	10	80	73	18	30	74	0.64
¾	50	10	80	75	18	35	65	0.63
¾	50		80	78	18	10	121	
¾	50		80	79	18	20	97	0.55
¾	50		80	79	18	30	77	0.66
¾	50		80	79	18	35	69	0.69

TABLE 2. TEST OF A SECOND PNEUMATIC DRILL.

†These investigations were conducted prior to the consolidation of departments at navy yards under Secretary Newberry and at the time they were made each department had its own supply of air hose.

Testing Device for Pneumatic Tools

For the above reasons a form of Prony brake was devised that answered all purposes remarkably well. It is shown in Fig. 1. The apparatus for the test is as follows:



Prony Brake Used to Test Pneumatic Tools

The drill *A;* vise *B* for holding it; gage *C*, reading by 5 pounds to 100 pounds at the machine; another similar gage at the line (not shown); a pulley *D* keyed to the drill spindle (pulley 6 inches diameter, with 1½-inch face); a water pan *E;* the brake itself *F*, resting on the knife edge *G;* and the scale *H*. The force on the brake was varied at will by means of the nut *I*.

The Tests

From Table 2 it is shown that for the small horsepower developed, that is, 0.51, the ⅝-inch and ¾-inch hose without leaders showed the same pressure at the machine and exactly the same amount of work done, and that when the leader was put on, the pressure and work fell slightly in both cases, a slightly greater drop being shown in the case of the ⅝-inch hose.

In Table 2 the scale reading was kept constant at 10 pounds by means of the adjustment nut *I*. A somewhat larger drill of another make was then used and the following data obtained:

Hose.							
Size, Inches.	Length, Feet.	Leader, Feet.	Hight of Lift, Feet.	Line Pressure, Pounds.	Hoist Gage Pressure, Pounds.	Time to Lift.	Horsepower.
¾	25		10	80	75	1 19½	1 56
¾	25		10	80	77	1 14⅘	1 67
¾	25	10	10	80	62	1 32	1 34
¾	25	10	10	80	62	1 30	1 37
¾	50		10	80	75	1 14⅘	1 67
¾	50		10	80	74	1 17	1 60
¾	50	10	10	80	62	1 29⅘	1 36
¾	50	10	10	80	62	1 30	1 37
¾	75		10	80	70	1 19⅘	1 56
¾	75		10	87	74	1 17	1 60
¾	75	10	10	80	60	1 34	1 31
¾	75	10	10	80	60	1 31	1 35
1"	25		10	80	55	1 34	1 31

2¾-inch plate, 5 feet wide, 20 feet 1 inch long, 6000 pounds load.

TABLE 3. TEST OF A 3-TON PNEUMATIC HOIST.

Test of a Second Pneumatic Drill

From the above data, which agree exactly with results in Table 1, it is shown that the ⅝-inch hose is perfectly capable of supplying a sufficient quantity of air to the machine both with and without leader to enable it to do practically the same amount of work as though ¾-inch hose had been used. (Note: Drop in pressure and work in consequence of use of leader.)

This test was made with four different scale readings, readings being kept constant by means of the adjustment nut *I*. Test was then made with a three-ton hoist and the following data obtained:

The results in the above table bear out those of Tables 1 and 2, showing that for all practical purposes ⅝-inch hose is equally as good as ¾-inch and that a marked drop in pressure and work occurs upon the use of a leader.

The following sizes of hose were decided upon for use in this department: 1¼-inch for mains; ⅝-inch for branches from main for drills, hammers, etc.; and 7/16-inch for leaders.

The advantages of using only ⅝-inch hose in place of ¾-inch, ⅝-inch and ½-inch are: (1) that ⅝-inch hose costs about three cents less per foot than ¾-inch and furnishes a better supply of air for the tool than half inch; (2) considerable reduction in actual cost of fittings for the ⅝-inch hose can be had from the cost of similar fittings for ¾-inch hose.

A Reversible Ratchet Wrench

By L. Deacon

The line cut shows a reversible ratchet wrench which we use in the shop for tapping, etc. The advantage of the tool for many kinds of work is that once set to

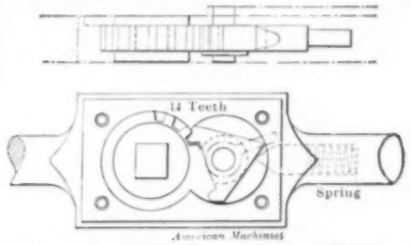


Fig. 1. Reversible Ratchet Tap Wrench

Fig. 2. The Reversible Ratchet Wrench In Operation

turn in the desired direction, the tap cannot be turned any other way.

Fig. 2 shows a man using it on a valve body.

Turbine Pump Characteristics

By Frederick Ray*

An explanation and discussion of the relations of head, power and efficiency to the output of a turbine pump. With usual design of impeller blades, an increase of water output entails a decrease of head and only a small increase in power required. This is a safeguard against motor overload in case of pipe breakage.

Closing the discharge pipe entails only a comparatively slight increase of head and a great reduction of power, thus protecting both the piping and the motor from overload.

The best means of capacity regulation is by speed variation, resulting in a material saving in power, as opposed to control by throttling.

The modern centrifugal pump has taken a position of ever increasing importance among the various types of pumping machinery of the world, and in the last few years its field of usefulness has increased from one of limited extent and small importance to one that embraces almost every pumping service.

Since the modern centrifugal pump is the growth of a very few years, and is the result of scientific design on the part of a few engineers, among the general engineering public there is still to be found a great deal of ignorance as to the real merits, capabilities and limitations of this type of pump.

It is the purpose of this article to bring out and discuss various characteristics of turbine pumps that must be clearly understood in order to properly select the most suitable type of pump for any particular service and to operate it most efficiently when in service.

The characteristics of the centrifugal or turbine pump depend directly upon the design and by its modification a wide variety of characteristics may be secured, making these pumps suitable for almost any class of service desired. The hydraulic design of the centrifugal pump is far from simple and requires an extensive theoretical knowledge of the subject as well as a large amount of experimental work to properly solve the many difficult problems involved.

*Chief engineer, Alberger Pump Company, New York City.

Characteristics

The operation of almost any type of machine can be most easily illustrated and understood by means of plotted curves showing the relations between the variables entering into the problem under consideration. With the turbine pump the simplest and most usual condition for which these curves are drawn is for constant-speed operation, requiring in this case for the complete illustration of the action of the pump, three distinct curves: One showing the relation between the capacity and head, one between capacity and power, and one between capacity and efficiency.

Fig. 5 shows such a set of curves derived from the test of a 10-inch single-stage turbine pump operating at the constant speed of 1125 revolutions per minute, a halftone of which is shown in Fig. 3. In this case the curve marked "Head" shows the variation of total head, which is the sum of the heads on suction and discharge of the pump, as the capacity is increased from zero up to the maximum quantity of water that can be forced through the pump, with the discharge wide open. The curve marked "Brake Horsepower" shows the variation in power required to maintain the speed constant, as the capacity is increased as above, while the curve marked "Efficiency" shows the variation in the efficiency of the pump under the same conditions.

Head Curve

From this curve can be obtained the total head against which the pump is capable of delivering any given quantity of water when operated at a speed of 1125 revolutions per minute, and conversely, if the pump was operated at this speed and gages on the suction and discharge were read, it would then be possible to determine the amount of water being pumped. In addition to this, directly below the point on the curve representing the head, would be found a point on the curve of brake horsepower giving the power being consumed; and in the same vertical line a point on the efficiency curve would show the efficiency with which this power was being utilized. It is thus plain that if a pump can be tested in the shop or elsewhere, where suitable apparatus is available, and a similar set of curves plotted from the results, a complete guide is obtained for the efficient and satisfactory operation of the pump in actual service.

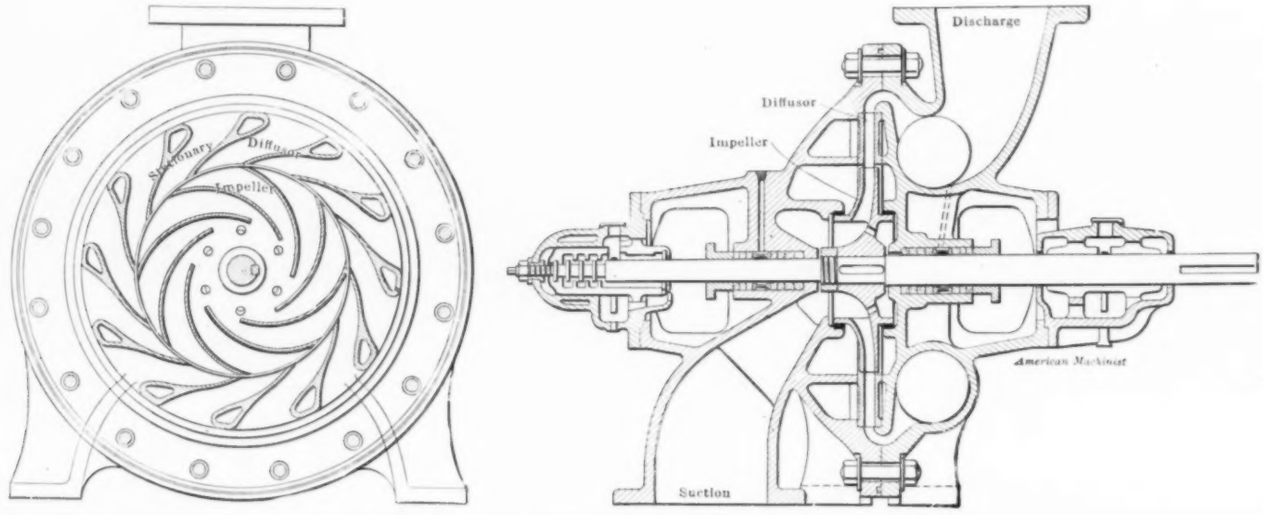


Fig. 1. Sectional Elevation of Single-stage Turbine Pump

Examining the head curve it is seen that with the discharge closed, when the water in the pump is simply being revolved around, the head generated amounted to 109 feet. As the discharge valve was gradually opened, this head increased until at a capacity of 500 gallons per minute the head amounted to 118 feet, and from there on it gradually decreased until at 930 gallons per minute it again amounted to 109 feet. On following this curve still farther, it is seen that the head drops to zero when a capacity of 1730 gallons per minute is reached, at which point the whole of the head generated by the pump is consumed within the pump itself, and none is available for useful work.

Power Curve

This is also of great importance, as the efficiency of the pump and the cost of operation depend directly upon the power consumed. In addition to this, the power curve furnishes the data from which a proper selection of the driving motor can be made, and shows the load that the motor will have to carry under any condition.

In Fig. 5 the power curve shows that it required 18 brake horsepower to drive the pump at a speed of 1125 revolutions per minute with the discharge entirely closed, and from this point the power gradually increased, as the capacity was increased, in nearly a straight line, until it reached a maximum of 44.5 brake horsepower at a capacity of 1550 gallons per minute. It then decreased slightly to 43.5 brake horsepower at the full capacity of the pump. From this it may be seen that it would be impossible to overload a motor of 40 or 50 horsepower to any great extent, by either a stoppage or breakage of the discharge pipe. Since at all points below 1550 gallons per minute the power decreases with a decrease in capacity, power may be saved by throttling the discharge so as to allow no more water to flow through the pump than actually required.

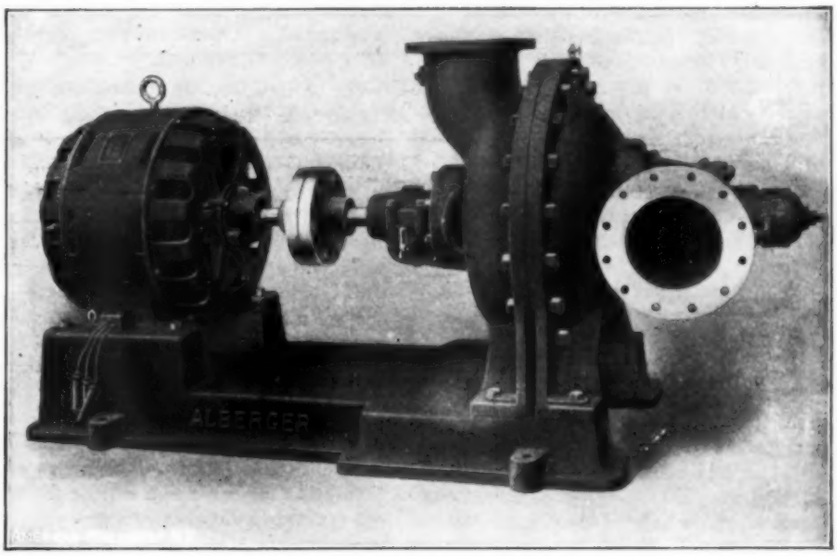


Fig. 3. Direct-connected, Single-stage 10-inch Turbine Pump

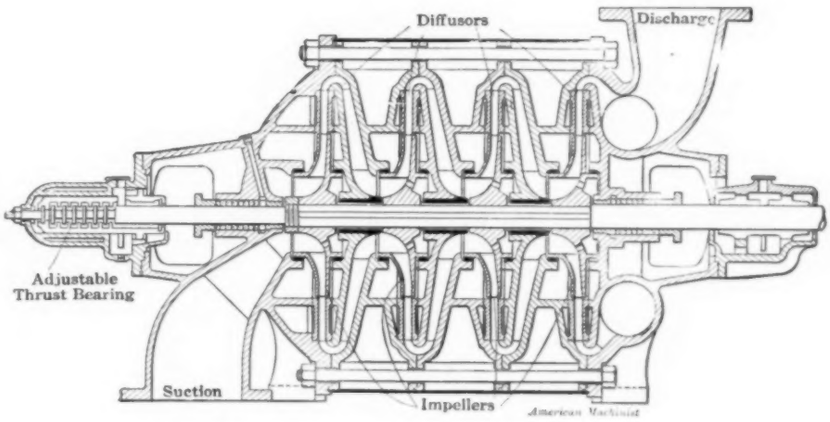


Fig. 2. Four-stage Turbine Pump. Sectional Elevation

Efficiency Curve

The efficiency is generally the one point about a turbine pump which receives the particular attention of the purchaser, with the result that most manufacturers are using every effort to produce pumps of the very highest efficiencies. High efficiency is naturally a desirable feature but the other characteristics are often of nearly equal importance.

In Fig. 5 the efficiency curve starts from zero, at zero capacity, which must always be the starting point, as the pump does no useful work until it discharges water, although it consumes power

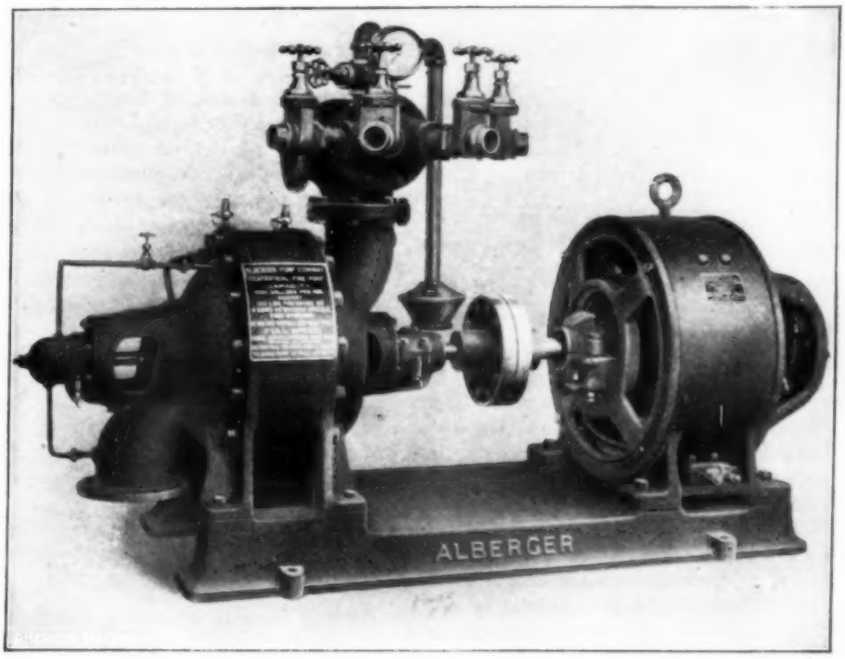


Fig. 4. Direct-connected, Two-stage 8-inch Underwriter Fire Pump

which is entirely wasted in friction. As the capacity increases, the efficiency gradually increases until it reaches a maximum of 71 per cent. at a capacity of 1100 gallons per minute, and then decreases to zero again at the full capacity of the pump, where again there is no useful work performed, as the head against which the water is pumped is zero. This particular curve shows many desirable features in its general form, inasmuch as it has a steep inclination at its beginning with a flat top and a steep ending, and incloses a large area.

Fig. 6 shows the characteristic curves of a 4-inch, two-stage turbine pump operating at a speed of 1720 revolutions per minute, while Fig. 7 shows similar curves of a 5-inch three-stage turbine pump operating at 1700 revolutions per minute. Both of these sets of curves are similar to the ones in Fig. 5 but are more remarkable on account of the high efficiency obtained with much smaller capacities. The pump giving the results in Fig. 5, however, was one of the first built of this design, while Figs. 6 and 7 represent more recent developments. Later pumps of the 10-inch size have shown efficiencies of over 74 per cent.

Fig. 8 is of considerable interest as it shows the characteristic curves of the 500-gallon standard underwriter pump operating at a speed of 1440 revolutions per minute, for direct connection to either a 25-cycle induction motor, or a direct-current motor, as desired. The underwriter specifications require this size pump to have a capacity of 500 gallons per minute against a pressure of 100

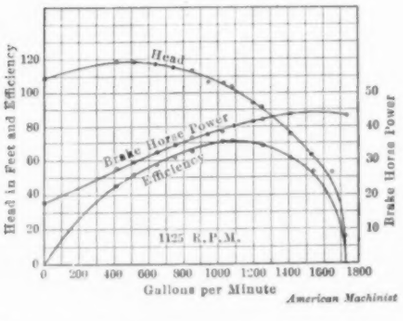


FIG. 5. CHARACTERISTICS OF 10-INCH SINGLE-STAGE TURBINE PUMP

pounds. It is seen from the curves that the capacity of the pump is about 10 per cent. over these requirements, but owing to the high efficiency the power required is considerably less than allowable. The curves clearly illustrate the many desirable features of this type pump for fire service, inasmuch as any number of streams, from one to three, can be thrown on the pump without overloading a 50-horsepower motor, or the discharge can be entirely closed without excessive pressure. Even under the extreme condition of a wide-open discharge the maximum overload on a 50-horsepower motor would not exceed 20 per cent.

The desirability of the turbine pump for fire service was recognized by the underwriters several years ago and after thoroughly investigating and testing the pumps of the various manufacturers, they prepared a complete specification covering all important points in the design and installation of pumps for this service, with the result that turbine pumps whose design and manufacture have been passed upon and approved by the underwriters are accepted by them for fire protection on an equal basis with any other type of pump. This has led to a considerable demand for such pumps, and from present indications it will not be many years before the turbine pump will be the leading type of underwriter pump.

The various curves so far shown are all very similar in their general form and represent a design of impeller that is well adapted to give high efficiency under the usual conditions that have to be met by such pumps. It is often necessary, however, to meet special conditions where sometimes the maximum head must be

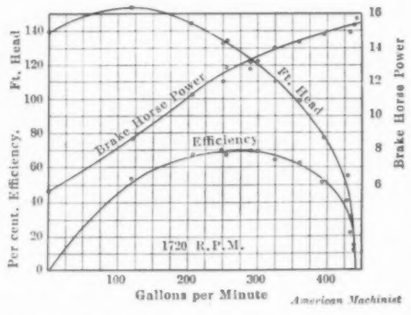


FIG. 6. CHARACTERISTICS OF 4-INCH TWO-STAGE TURBINE PUMP

kept within a few per cent. of the normal working head and at other times just the reverse is wanted, and by suitable design either of these conditions can be readily fulfilled. A pump designed to meet the first of these conditions would in general have a greater maximum capacity and a power curve of greater steepness and range than those illustrated. The point of maximum efficiency would also be apt to occur at a greater capacity. For the second condition the maximum capacity would be less, the power curve would become more nearly horizontal, showing a greater consumption of power at zero capacity, while the point of maximum efficiency would occur at less capacity. From this it is seen that a horizontal head curve means a steep power curve, while a steep head curve results in a horizontal power curve.

REGULATION OF CAPACITY AND HEAD

Another point of great importance is the regulation of capacity and head of a turbine pump. There are three methods of doing this: by varying the speed, by throttling the discharge, and by varying the number of stages. Varying the number of stages in a single self-contained pump is the most complicated and troublesome to work out in a satisfactory manner, and is practically used only in connection with mine-sinking pumps which are used under widely varying heads. This method is very satisfactory where the additional stages are contained in a separate pump independently driven, and is much used for city water-works service

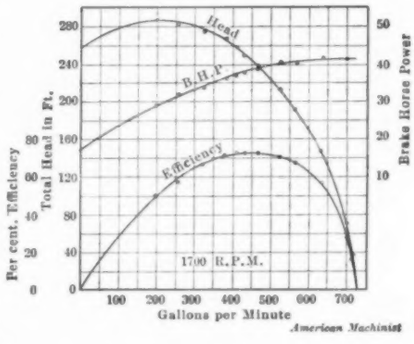


FIG. 7. CHARACTERISTICS OF 5-INCH THREE-STAGE TURBINE PUMP

where increased pressure is required for fire service. Where the extra stages are contained within the same pump, it is almost impossible to make the design so that the idle impellers will not be running in water, and without accomplishing this, that method of regulation is not of much value.

THROTTLING THE DISCHARGE

The results to be obtained by throttling are shown by the curves already given. Thus for any given speed the power used depends only upon the quantity of the water flowing through the pump, since the head that the pump generates depends only on the quantity being pumped. This head can be utilized, or wasted in the throttle valve, as may be necessary, but whichever way the head is utilized the action of the pump is the same. If all the head is utilized, the efficiency with which the water is being pumped is given by the corresponding point on the efficiency curve, but if any of the head is being wasted in the throttle valve the above efficiency must be multiplied by another factor whose value is the ratio of the total head utilized to the total head generated by the pump.

To illustrate this point with an example, take Fig. 5 and assume that this pump is operating against a constant head of 100 feet, and that it is required to find the efficiency with which it is possible to pump 800 gallons per minute. From the curves it will be seen that the efficiency of the pump itself is 65 per cent. and the total head generated is

113 feet. Consequently the efficiency of pumping is $0.65 \times \frac{100}{113} = 57.5$ per cent. This same result can be obtained by calculating the water horsepower of 800 gallons per minute against 100 feet, and dividing by the corresponding brake horsepower from the curve. By making similar calculations on the several curves that are illustrated, it can be readily seen that the objection to this method of regulation is the considerable loss in the efficiency of pumping that results therefrom.

Speed Variation

Undoubtedly the best method of regulating the capacity of a turbine pump is by means of speed variation, and as the proper selection of the method of control is of great importance, it seems well worth while to discuss the matter thoroughly.

Fig. 9 shows the characteristics for the same pump as those in Fig. 5, derived from the results there illustrated, on the assumption that the total head remains constant at 100 feet, while the capacity is varied by varying the speed. On this assumption the head curve becomes the horizontal straight line at the 100-foot mark, instead of the curve shown in Fig. 5. There has also been introduced a curve marked "R.P.M." which gives the revolutions per minute required for any given capacity against the constant head of 100 feet. The power and efficiency curves are also changed, as is apparent by a comparison with the original curves reproduced in dotted lines.

On looking at the speed curve, it is evident that to generate a head of 100 feet without delivering any water, requires a speed of about 1080 revolutions per minute. As the capacity is increased,

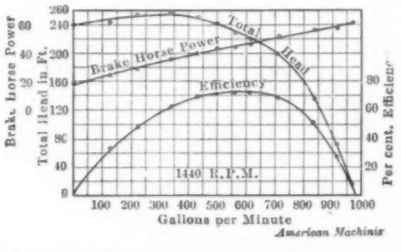


Fig. 8. Characteristics of 6-inch Two-stage Turbine Pump at Constant Speed

the speed required gradually decreases, until it reaches a minimum of 1050 revolutions per minute at a capacity of 450 gallons per minute, which also corresponds with the point of maximum head under constant speed operation. From this point on, the speed gradually increases until at a capacity of 1130 gallons per minute it reaches a value of 1125 revolutions per minute, at which point the original head curve crosses the 100-foot mark, as would be expected. As the capacity is still further increased, the required speed increases at a more rapid rate until, at a capacity of 1400 gallons per minute it becomes 1300 revolutions per minute, and would continue to increase in the same curve until the maximum capacity of the pump is reached, beyond which it would be useless to go farther, as it would be impossible to pump more water at any speed whatsoever.

The power curve is seen to have changed its form materially, becoming much steeper, so that the power at capacities less than 1130 gallons per minute is considerably less than at constant speed, while at greater capacities it increases rapidly. Below the intersection with the former power curve the power required is less, due mostly to the fact that less work is being done by the pump, but also due to the better efficiency with which the work is done, as is shown by the efficiency curve. Beyond this intersection the increase in power is entirely due to the increased output of the pump, since from the efficiency curve it may be seen that the efficiency under these conditions is considerably

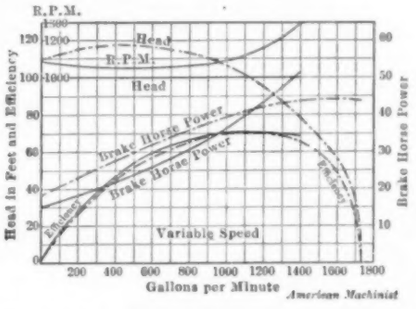


Fig. 9. Characteristics of 10-inch Single-stage Turbine Pump Operating Against Constant Static Head

better than at constant speed. It is seen by comparing the new with the old power curve, that it would take as much as 25 per cent. more power at some points to drive the pump at constant speed and decrease the capacity by throttling, than would be necessary to secure the same capacity by means of speed regulation. The efficiency curve is flatter with as high, or higher, efficiency at every point and consequently incloses a larger area, thus giving a greater average efficiency throughout the range of capacity of the pump.

The conditions illustrated in Fig. 9, which were based upon the assumption of a constant total head, are the least adapted to show a saving in power by means of speed regulation, and they are also conditions that practically never occur in actual practice, inasmuch as there must always be some frictional resistance to every pumping system making use of pipes to convey the water. In fact, in the usual installation the pipe friction amounts to at least 10 to 20 per cent. of the static head at normal capacity, and for many services the total head is composed entirely of frictional resistance.

As an illustration, the curves in Fig. 10 have been drawn from the data of Fig. 5, based upon the assumption that the total head is 100 feet at a capacity of 1130 gallons per minute, and that this head is composed of 80 feet static head and 20 feet friction head. Since the frictional resistance varies as the square of the capacity, the head curve can be drawn at once, as shown. Having the head curve, the speed curve can be drawn,

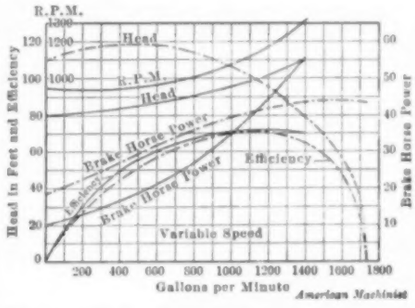


Fig. 10. Characteristics When Operating Against Combined Static and Friction Head

and it may be seen that for capacities less than normal, the speeds are lower than required for the conditions in Fig. 9. For capacities greater than normal, the speeds are higher. The power curve is of the same general shape as in Fig. 9, but steeper, showing that at capacities less than normal, still less power is used, while for greater capacities more power is necessary. Under these conditions it is seen that nearly 60 per cent. more power would be required, at some points, to drive the pump at constant speed and regulate the capacity by throttling. The efficiency curve shows as good, or better, efficiency at every point and a higher average efficiency throughout.

When the head is entirely of friction, regulation by speed variation becomes even more important if economical results are desired. Under these conditions, when the capacity is zero, the head is also zero and the speed required is likewise zero. It will also be found that the capacity will increase directly as the speed, and the head generated by the pump and required to overcome the friction, varies as the square of the speed. The efficiency will be found to be nearly constant at all speeds, and consequently the efficiency curve would be nearly a horizontal straight line. Therefore, if the frictional resistance is known at any capacity, the head curve can be drawn at once. The speed curve follows immediately, and if an efficiency curve has been determined at any constant speed, the efficiency curve for these conditions can be constructed. The power curve can be derived from these curves, and it will be found that the power varies as the cube of the speed. Since the head varies

as the square of the speed, and the capacity as the first power of the speed, the output of the pump, in work, varies as the cube of the speed, and is directly proportional to the power input.

From the previous illustrations and examples, it would appear that the most efficient method of capacity regulation of a centrifugal pump is by means of speed variation. Even in the case where the number of stages is varied, the variation in head or capacity resulting therefrom can occur only in jumps, or steps, and speed variation is necessary to obtain regulation between these steps. For conditions similar to those illustrated in Fig. 10, which are representative of the majority of cases, a speed variation of 10 per cent. above and below normal will be found to be ample to give all the regulation that is required. This amount of variation can usually be obtained at very slight expense, with either electric-motor, steam-turbine or steam-engine drive, and the power saved would, in most cases, pay for the additional outlay in a very few months of operation.

There are also other reasons which make it desirable to have some variation in the speed permissible, the principal reason being the difficulty of accurately estimating the friction loss in any given pipe system. There are so many variable factors entering into this problem, such as age of pipe with the resulting conditions in the interior, effect of elbows, bends and other fittings, that no one can hope to calculate the friction exactly. The general run of engineers who have had no particular experience in this line, almost invariably underestimate the friction loss, while those of more experience calculate the results as closely as they can, then add enough to insure being on the safe side.

The result of the first method is that when the pump is installed it is found to be short on capacity, which, on application of gages to the suction and discharge, is found to be due to the head being greater than that for which the pump was designed. If the speed cannot be increased, the only way out of the difficulty is to design a new impeller for the pump, and in some cases, where the first impeller was as large as could be used in the pump, it might be necessary to purchase an entirely new pump.

The second method tends toward a pump designed for a head greater than actually exists, with the result that on installation the pump discharges too much water, the motor consumes too much power and the efficiency is low. The pump designer generally aims to be safe on capacity, so that usually the pump is a little over capacity at the required head. In designing a centrifugal pump it is difficult to obtain results within a few per cent. of the calculated, and in fact, two pumps made from the same design seldom operate the same, owing to the differences in castings and machine work. Generally the error from this source in a standard pump with which the designer is perfectly familiar, would not be serious, and an error of 5 per cent. or less, either way, in the capacity at the stipulated head, should be considered satisfactory for commercial work. These errors are entirely eliminated by a small variation in speed either way from normal, and on this account alone, provision for speed regulation is well worth the expense of procuring.

A One Sided Apprenticeship

Special Correspondence

An interesting case in which the apprentice was in practical slavery without even the guarantee of a chance to work at the trade. Laws and contracts which belong to the dark ages.

A very interesting case has just been decided by Judge Henry Tappan, of the Circuit Court, in Port Huron, Mich., in favor of Gilmour V. Smith, a young man who was sued by the Draper Manufacturing Company for breach of an apprenticeship contract. It was a four years' agreement, from which we extract a few clauses:

"That during the whole of the term mentioned the said minor . . . shall give and devote to the company his whole time and labor, and shall not at any time absent himself from the service of said company without its consent . . . nor join any society which might at any time within the said term cause his absence from his regular work in the service of the said company."

Although this contract states that it is "For the purpose of learning the trade of machinist," it stipulates "that the company, its foreman or other superior officers, may at any time or times during the term, temporarily assign and appoint the said minor to the performance of such work as may be required in any other branch or department of the business of the said company, and for such length of time as the company may desire."

"Nothing herein contained shall bind the company to keep the said minor as an apprentice should he become insubordinate or unsatisfactory to its superior officers in any respect. The company or its superior officers shall have full power to suspend or discharge the said minor from the service of the company for any good cause. It is also expressly agreed that the superior officers of the company . . . shall be the sole and final judge between the parties hereto of all questions as to any misconduct, neglect of duty, inefficiency or insubordination, or to any other act."

After working two years and three months the apprentice absented himself from work without excuse, and thereupon the company suspended him for 10 days, after which he refused to continue to work. Judge Tappan called attention to the discrepancy between the apprenticeship for the purpose of learning the trade and the clause requiring him to perform any other work that the company might demand, as well as the clause making the company the sole and final judge in all questions or as to any other act, and that, as there was no provision for allowing a vacation, the local law made him subject to arrest and imprisonment if he should fail to labor every working day for the four consecutive years. He also quoted from the law to show that any such failure makes the minor subject to return to his master or commitment to jail for a term not exceeding 20 days unless sooner discharged by his master.

The company evidently had a perfect legal right to make such a contract, but as this particular contract did not comply with the law which places all such power in the hands of the directors, while this was signed solely by the manager and the boy's father, the verdict was given for the boy, who was discharged.

There is evidently considerable room for improvement in both the laws of the State of Michigan in this respect and in the form of apprenticeship contract which was used in this case. Such a contract, backed up by a law, makes a term of apprenticeship practically equal to a four years' voluntary slavery and is hardly the way to induce boys to learn a trade.

The wood workers of Paris are said to be preparing for a gruesome object lesson on the result of not enforcing the laws regarding the guarding of woodworking machinery. All the maimed and disabled workers in this line are to parade the streets of Paris, exhibiting the results of their injuries. It is reported that stricter safety law enforcement is expected.

Cutting Properties of Tool Steel—I

By Edward G. Herbert*

The "Cube Law of Cutting Speed" as used to develop the "Heat Theory of Durability" with a large mass of evidence to prove its correctness.

Tests in which the speed of cutting tool was kept constant and the feed increased, and tools run dry and with hot and cold water to alter the temperature at their cutting edge. The single and double peaked curves produced by the tests and the practical information to be obtained from them.

*Director, Edward G. Herbert, Limited, Manchester, Eng.

In a previous article in the AMERICAN MACHINIST on page 822 of Part 1, Volume 32, there was published a description of my tool-steel testing machine, and of some preliminary results obtained by its use. Readers may remember that samples of tool steel, to be tested on this machine, are made into cutting tools of standard shape. They are tested by being caused to turn away, with a feed of 0.0012 inch per revolution, a standard steel tube that is ¾ inch in diameter and ⅝ inch bore.

The durability of the steel is measured by the length of tube it will turn away before attaining a definite degree of bluntness. As the test proceeds, the wear of the cutting edge is measured by a micrometer, attached to the machine. The results of tests, made at different cutting speeds, are plotted in the form of a "speed curve."

The simplest form of speed curve, as taken from a carbon steel, is shown in Fig. 1. The durability of the steel, as measured in inches of tube turned away and shown by the hight of the curve, is very low at low cutting speeds. That is, the tool is very quickly blunted at these speeds. As the speed is increased, the durability increases until it attains a maximum at a certain speed that depends on the quality of the steel. And, as the speed is further increased, the durability decreases toward zero.

CUBE LAW OF CUTTING SPEED

From the first it was suspected that these changes in durability were dependent on the temperature at the cutting edge. Thus a theoretical investigation of the heat evolved in cutting led to the formulation of the "cube law of cutting speeds" (AMERICAN MACHINIST, Volume 32, Part 1, page 826).

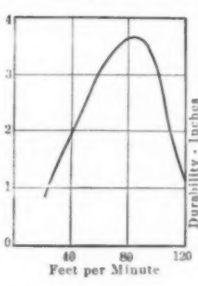


FIG. 1. DURABILITY OF CARBON STEEL AT INCREASING SPEED

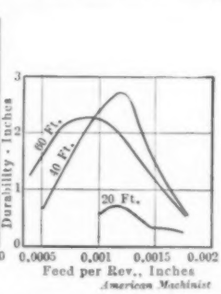


FIG. 2. DURABILITY OF CARBON STEEL AT INCREASING FEED

According to this law the durability of the cutting tool remains constant when the speed varies inversely as the cube root of the product of thickness of chip by area of cut. The correctness of this law was proved by the results of F. W. Taylor's experiments.

It is strong presumptive evidence of the correctness of the theory, that the durability of the tool depends mainly, if not entirely, on the temperature to which the edge of the tool is raised in cutting. But it cannot be said to prove that all the changes of durability shown in the typical speed curves are due to changes in temperature, and for this reason Mr. Taylor's experiments were conducted on the basis of constant durability. The combinations of cut and speed were so chosen, that in every case the tool failed at the end of 20 minutes' run. That is to say, Mr. Taylor worked, throughout his experiments, at a definite point on the speed curve or, more correctly speaking, on the temperature-durability curve, of his tools; probably a point on the right-hand or descending portion of the curve, where a simple increase of speed or of cut would reduce the durability of the tool.

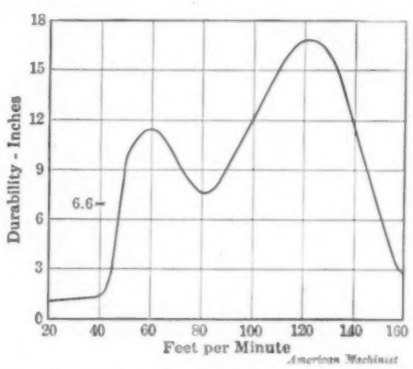


FIG. 3. TUNGSTEN-VANADIUM TOOL, CUTTING WITH AND WITHOUT ARTIFICAL HEAT

HEAT THEORY OF DURABILITY

If the heat theory of durability be correct, it must apply also to the left-hand or ascending portion of the curve. A tool working at this part of its speed curve should have its durability increased by an increase of its temperature, and this should hold good whether the temperature were increased by running it at a higher speed, by taking a heavier cut, or by the application of heat from an external source.

In order to test this point, three series of tests were made with the tool which produced the speed curve in Fig. 1. In these tests the speed was kept constant, but the feed was gradually increased. The results are shown in Fig. 2. In this chart horizontal distances represent the thickness of chip, or feed; the two being identical in the testing machine. Vertical distances represent the lengths of tube turned away before the standard blunting of the tool had taken place. The tests were made at 20, 40 and 60 feet per minute. In each case, the curve obtained is of the same type as the speed curve, in Fig. 1, that was taken from the same tool.

These results give support to the heat theory of durability, but they do not definitely establish it. It is possible that the changes of durability consequent on increase of speed and of feed, though similar in character, may be due to different causes. It was, therefore, decided to test the theory further by applying artificial heat to the tool which was cutting.

TESTS WITH ARTIFICIAL HEAT

In Fig. 3 is shown the speed curve of a tungsten-vanadium steel. This steel was selected for the heat experiment because its speed curve rises with great abruptness, between a cutting speed of 40 and 50 feet per minute. This abrupt rise should, according to the heat theory, indicate a great increase of durability for a relatively small rise in temperature. It should, therefore, be possible to effect a considerable increase in the durability

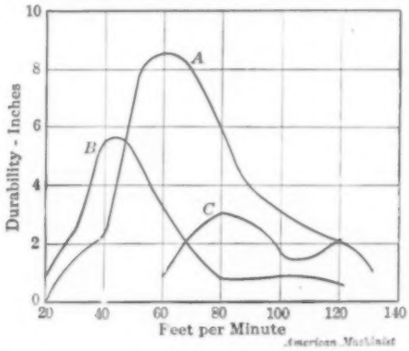


FIG. 4. CARBON-STEEL TOOL, CUTTING WITH AND WITHOUT ARTIFICAL HEAT

of this tool, when cutting at 40 feet per minute, by artificially increasing its temperature.

The speed curve was made under the usual conditions, with the cutting tool flooded with a copious stream of water from a circulating pump. Gas burners were arranged under the tray of the testing machine and the water was caused to circulate until its temperature became constant at 150 degrees Fahrenheit. The durability of the tool was then tested at 40 feet per minute under the stream of hot water, and it was found that the length of tube cut away under these conditions was 6.6 inches, against 1.4 inches in the previous test with cold water. The heating of the water from 60 to 150 degrees was equivalent to increasing the cutting speed from 40 to 48 feet per minute.

Tests with Carbon Steel

High-speed steels are supposed to become harder as they become hotter and it is possible that the increase of durability was due to this cause. No such increase of hardness at higher temperatures is, however, known to take place in the carbon steels, hence special interest attaches to the experiments.

Those results are shown in Fig. 4. Curve *A* is the speed curve of a carbon-steel tool, working under ordinary conditions with cold water. When this curve had been made, the gas burners were placed in position and the water was brought to a temperature of 152 degrees Fahrenheit.

A complete speed curve was then made from the same tool, cutting under hot water. This curve is shown at *B*. The result is a striking confirmation of the heat theory. The whole curve is moved to the left. At all the speeds up to 48 feet per minute the durability of the tool is increased by the application of heat. At all higher speeds it is decreased.

This seems to prove conclusively that the changes of durability shown by the typical speed curve are entirely due to changes of temperature at the extreme cutting edge. A rise in temperature is, in some way, beneficial to the steel up to a certain point and afterward detrimental.

It will be noticed that curve *B*, made with hot water, has a lower maximum durability than curve *A*. It was difficult to account for this, except on the supposition that the temper of the tool had been drawn, either by continued immersion in hot water or by repeated grinding. In order to test this, a fresh speed curve *C* was made with cold water. The result of drawing the temper was to lower its curve and move it to the right more than the original cold-water curve *A*.

Dry and Wet Cutting

To further test the heat theory, a speed curve *A*, Fig. 5, was made from a carbon-steel tool, cutting under cold water. A second curve *B* was then made from the same tool cutting dry; under which conditions it, of course, became much hotter.

In this, as in the previous case, the effect of increasing the temperature of the tool was to increase its durability at the lower speeds, and decrease it at the

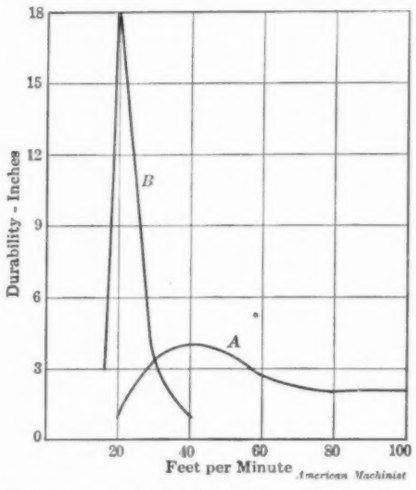


Fig. 5. Carbon Tool, Cutting Dry and with Water

higher speeds; the curve being compressed and moved to the left. A most unexpected phenomenon appears, however, in the enormous increase in the maximum durability of the tool. No adequate explanation is at present forthcoming.

It seemed possible that the effect might be caused by a softening of the test

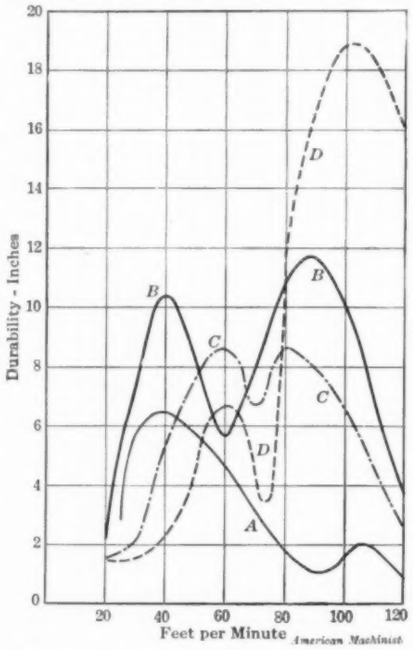


Fig. 6. Double-peaked Speed Curves

tube, which became considerably heated, owing to its thin section. The test tube is of 0.60 per cent. carbon steel that is so treated as to be semi-hard. It would thus be possible to soften it by raising its temperature.

In repeating the test with a tube of very soft low-carbon steel, the increase of durability was equally marked. It therefore seems improbable that the phenomenon was due to the softening of the tube, and it is difficult to suggest any other satisfactory explanation. It is of some importance to know that in taking a very light finishing cut at a low speed, the tool keeps its edge better without water.

Application of Law

A considerable body of evidence has now been brought forward in support of the heat theory of durability, and it seems safe to conclude that all the changes in the durability of a cutting tool are mainly, if not entirely, dependent on the temperature of the cutting edge and independent of the speed or weight of cut except in so far as these affect the temperature. This theory is important as forming a connecting link between the results given by the testing machine and the cutting operations of the workshop.

On the testing machine the conditions of cutting are quite special. The thickness of the chip is only about a thousandth of an inch, and it might appear that the results of cutting operations conducted on so microscopic a scale would throw very little light on the behavior of cutting tools under the conditions of the modern workshop.

When, however, it is realized that each speed on the testing machine corresponds to a definite temperature of the cutting edge; that the range of temperatures so produced includes the whole range of temperatures occurring in practical work, and that the durability of any tool depends on the temperature to which it is raised in cutting, it becomes apparent that all the changes of durability that are manifested on the testing machine must necessarily take place at the same temperatures under ordinary working conditions.

In considering what follows it will be useful to bear in mind that the speed curve is really a temperature-durability curve, though it is not at present possible to say with certainty what are the actual temperatures corresponding to the various cutting speeds.

Double-peaked Curves

In my former article it was stated that in the case of carbon steel, and possibly also in that of high-speed steel, the speed curve has a curious depression or dimple at one particular speed; that is to say, the durability of the cutting tool is less at that speed than at speeds which are higher or lower. This phenomenon is now known to be exceedingly common, and it is not confined to any one class of steel.

An example of a dimpled or double-peaked curve has been given in Fig. 3, and further typical curves are given in Fig. 6. There *A* is the speed curve of a

carbon steel, and tool *B* is from a steel containing 11.8 per cent. tungsten, that was water hardened at a white heat. This latter steel has been used in its maker's own works for machining articles of hard material, that could only be worked at very low speeds. Its special suitability for this class of work is confirmed by the speed curve. Its durability, at the low speeds, is considerably greater than that of the carbon steel. Curve *C* is taken from a high-speed steel, and *D* from a tungsten-vanadium steel.

The depression may occur in any part of the curve of any steel. It is occasionally so marked as to amount to an almost entire loss of durability, at a speed intermediate between speeds that give the tool its hightest durability. It might appear impossible to fail to detect it, if it really occurred in practical cutting operations.

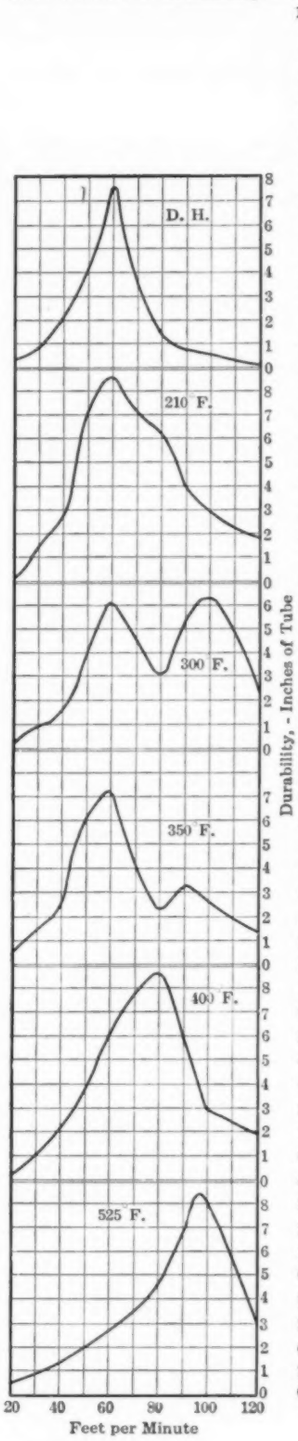


FIG. 7. EFFECT OF TEMPER ON DURABILITY OF CARBON STEEL

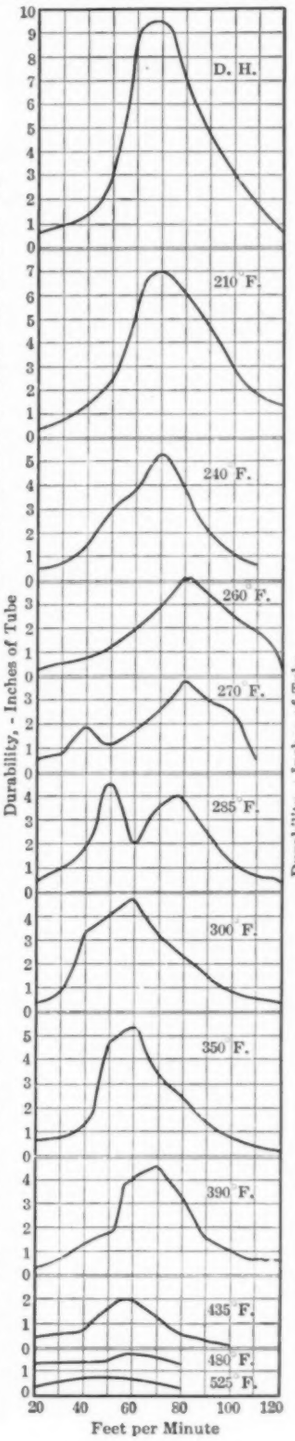


FIG. 8. EFFECT OF TEMPER ON DURABILITY OF CARBON STEEL

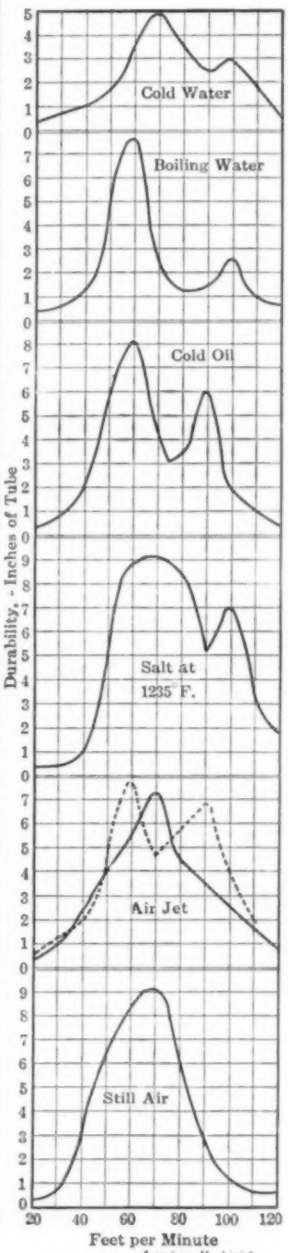


FIG. 9. EFFECT OF HARDENING PROCESS ON DURABILITY OF TUNGSTEN-VANADIUM STEEL

OCCURRENCE OF DEPRESSIONS

Before coming to this conclusion it will be well to inquire how the phenomenon would appear to a workman who had set his speed and cut to the critical point on the speed curve of his tool.

The tool would be rapidly blunted and would be thought to have become soft, or to have been set to too high a speed. The obvious remedy would be to reharden the tool, or reduce the speed.

Rehardening the tool is likely to change the form of its speed curve and eliminate or alter the positions of the depression. Reducing or increasing the speed would set the tool on a higher part of its speed curve and increase its durability. The workman is not liable to experiment in the direction of increased speed, but where he has, the durability of the tool has been improved.

If the speed and cut are made such as will bring the tool to a point on the right-hand peak of the curve and it is started cold, it must obviously pass through the lower temperature, corresponding to the depression before its edge can attain the high temperature corresponding to this point. If the rise in temperature is gradual we should expect the tool to be blunted to some extent while passing through the critical temperature of low durability. Once having risen above this temperature it would recover its durability.

Those who have occasion to watch the behavior of cutting tools will testify that this is an exceedingly common occurrence. The tool soon after being set to work seems to be on the point of failing—it loses its sharpness rapidly—but if allowed to continue cutting it "builds up," that is, it regains its durability and cuts for a long time without further loss of sharpness.

The observed behavior of cutting tools is exactly what the form of the speed curve would lead us to expect.

EFFECT OF TEMPER

The same steel does not always give the same form of speed curve. A tool that gives a single-peaked curve may, after rehardening, give a double peak, or the curve may be narrowed or broadened or shifted bodily to the right or left.

In order to ascertain what is the precise effect of temper on durability and on the form of the speed curve, a number of experiments were made with carbon steels. This work was carried out in coöperation with Henry Brearley, of Sheffield, who kindly undertook the heat treatment and chemical analysis of the steels.

The first tests were made with a steel having the following composition:

	Per Cent.
Carbon	1.33
Manganese	0.39
Silicon	0.19
Sulphur	0.038
Phosphorus	0.033

The tools were all cut from the same bar, ¾x½ inch in section and quenched in water, from 1435 degrees Fahrenheit. One was left dead hard and the remainder were tempered by being immersed for 30 minutes in an oil bath at the following temperatures, respectively, 210, 300, 350, 400 and 525 degrees Fahrenheit. The tools were then tested and the resulting speed curves are given in Fig. 7.

It will be seen that the dead-hard tool gives a narrow curve with a maximum at 60 feet. The tool tempered at 210 degrees gives a broader curve in the same position.

The curve of the 300-degree tool shows a remarkable change. It is much broader than the preceding and is broken into two distinct peaks with a deep depression between them. In the next, or 300-degree curve there are also two peaks, but the first has increased in hight, while the second has almost disappeared. In both the 400- and 525-degree curves only one peak developed, and it moved progressively to the right.

These show that the greatest durability at the highest speeds is obtained from the softest tool.

Second Series of Temper Tests on Carbon Steel

In order to confirm and trace out more completely the changes in the speed curve, a second series of tests was made, with a steel of the following composition:

	Per Cent.
Carbon	1.25
Manganese	0.27
Silicon	0.15
Sulphur	0.011
Phosphorus	0.015

The tools were treated in exactly the same manner as those in the first series, but were tempered at a closer range of temperatures. Their speed curves are shown in Fig. 8.

In this, as in the first series, the dead-hard tool gives a curve with a high, narrow peak, but with the maximum durability at 70 feet instead of 60. Tempering at 210 and 240 degrees causes the curve to retain its position, but it becomes lower. At 260 degrees the maximum moves to 80 feet and the downward slope of the curve loses its concave form.

At 270 degrees we see the remarkable phenomenon of a first peak sprouting, as it were, from the base of the second. At 285 degrees the first peak has outgrown the second and at 300 degrees and higher temperatures, only the first peak remains. It gradually shrinks in size and at 390 degrees there is a slight movement to the right, but there is nothing to correspond with the very marked movement to the right in the lower curves of the previous series. Except in this particular the two series closely correspond.

Fig. 9 shows the effect of the hardening process on the durability of tungsten-vanadium steel.

Saw for Sectional Packing Rings

Fig. 1 shows the device used at the Beech Grove shops of the Big Four railroad for cutting up sectional rings for piston packing. It consists primarily of a worm-driven saw and a table for holding the piston rings so as to cut them at the proper places. This table is divided for rings of different size and can be readily adjusted from one side to the other.

By referring to the detailed illustration in Fig. 2, it can easily be seen how the ring is clamped between the point of the V-shaped block *A* at the spring-actuated plunger *B*. By locating the stop pin in the proper hole, according to the schedule given, the cuts are easily made. Some of the sawed sections are shown on the table in front of the saw.

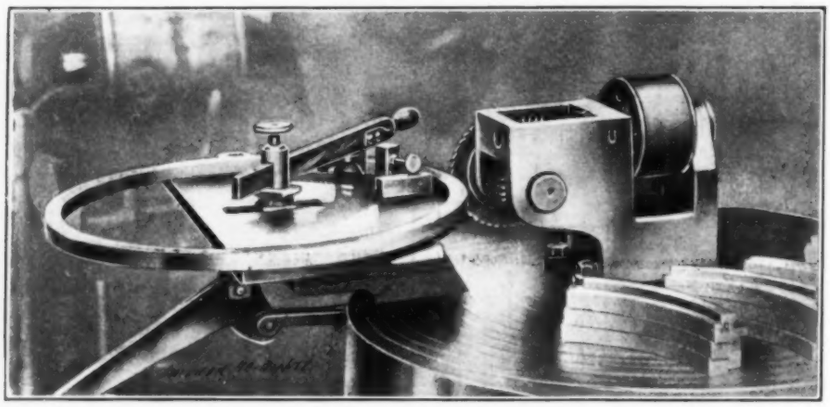


Fig. 1. Piston-ring Sawing Jig

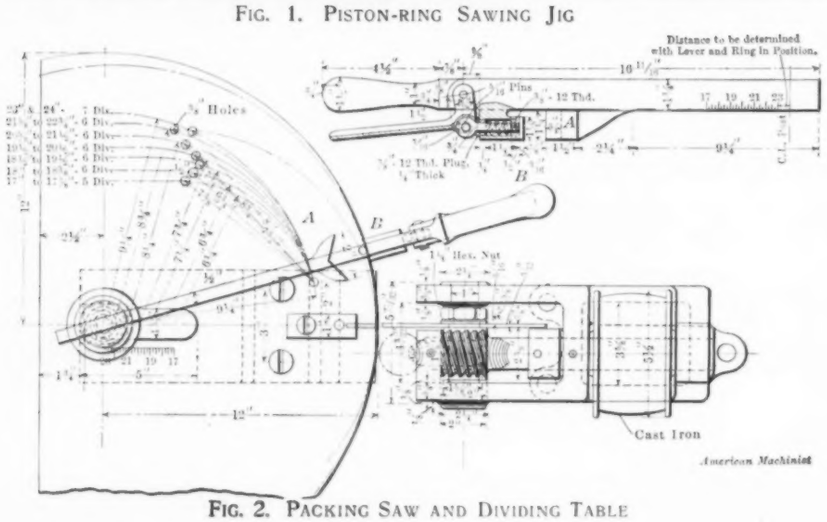


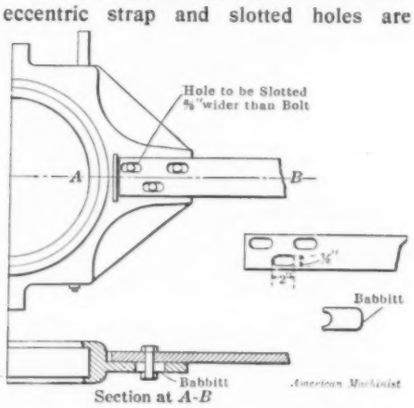
Fig. 2. Packing Saw and Dividing Table

Preventing Locomotive Eccentric Blades from Slipping

By W. J. Shadle

The line cut shows a method to prevent eccentric blades slipping after the valves are set if the nuts on the blade bolts should become loose. It is accomplished as follows:

A hole is drilled the size of bolt in the eccentric strap and slotted holes are



Preventing Eccentric Blades Slipping

drilled in the blades. After the valves are set, an assortment of cast babbitt blocks is at hand and they fit the openings in the blade on each side of the bolt, which makes the entire structure solid.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

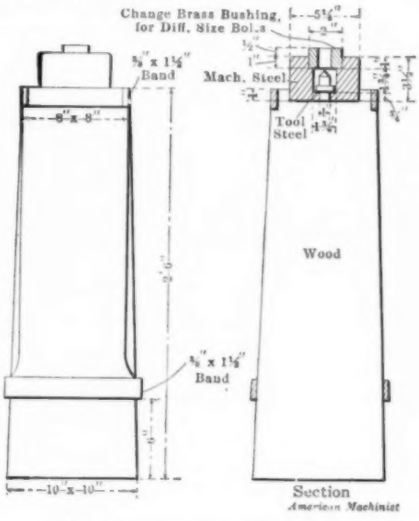
Drilling Tell-tale Holes in Staybolts

As all firebox staybolts are required to have 3/16-inch detector holes drilled in outside end of bolt, I designed and put in use the method of drilling as shown by Figs. 1 and 2. These consist of home-made rotary air engine which drives the drill at required speed and is operated by boy who drills the bolts quickly and cheaply.

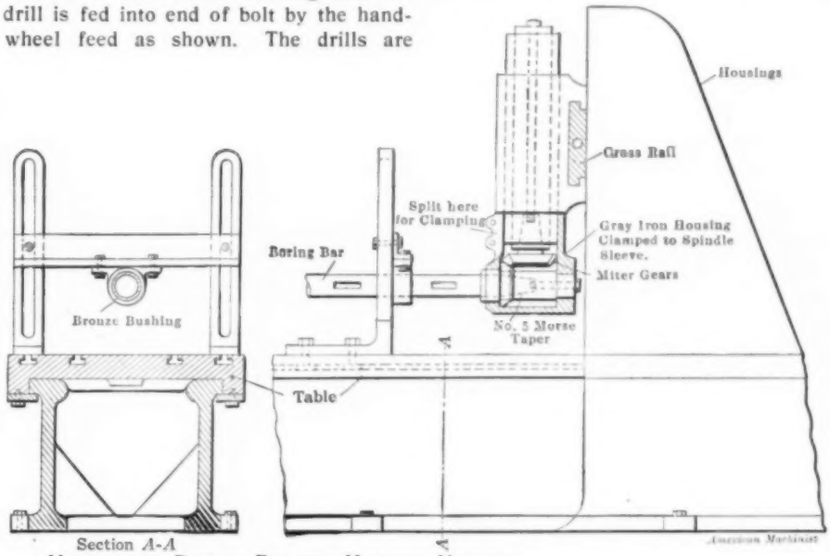
The bolts are first centered on end to be drilled by simple device shown in Fig. 1, which is done by simply hitting the bolt one blow which drives it in center punch in place of putting the bolt in vise and using the center punch. We have different sized bushings to fit the bolts, which hold the bolts central with center punch.

After the bolts are centered they are held in a drill-frame bushing and the drill is fed into end of bolt by the hand-wheel feed as shown. The drills are made from high-speed steel and no oil is required in drilling.

CHARLES MARKEL,
Shop Foreman, C. & N. W. Ry.
Clinton, Ia.



STAYBOLT-CENTERING DEVICE



HORIZONTAL BORING RIG FOR MILLING MACHINE

Converting a Slab Miller into a Boring Mill

The cut shows how an Ingersoll milling machine was transformed into a horizontal boring mill at small expense and to excellent advantage.

The table of the machine is 10 feet long and, with this rig, holes 4 feet 6 inch long can be bored in fine style.

With brackets, etc., for supporting outer end of the boring bar, arranged as shown, almost the full range of the machine can be utilized. Advantage can also be taken of the micrometer dials, stops, etc., with which the machine is equipped, when more than one hole is to be bored in the same piece. This rig can be put on or taken off the machine in short order and does not interfere in any way with its functions as a milling machine, but rather increases its usefulness for that class of work, as a job too large to pass between housings may be machined off by means of a face mill substituted for the boring bar.

This attachment can be used on the side spindles of the milling machine as well as on the vertical, and in this way will work into many places for drilling, boring and milling, which would otherwise be awkward to reach.

W. J. BISSETT.
Buffalo, N. Y.

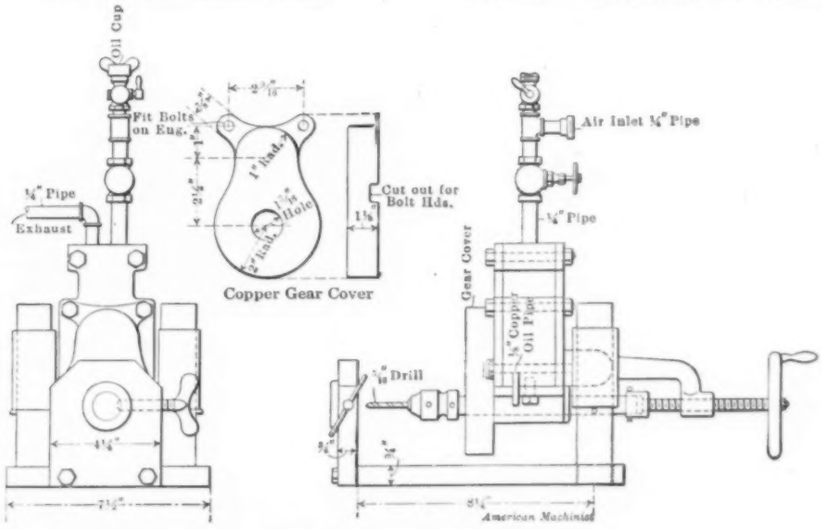
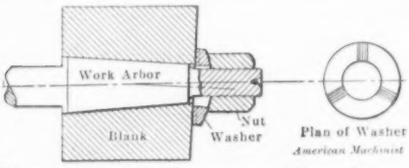


FIG. 2. STAYBOLT DRILL

Use of the Convex Washer

If the face of a blank is not true, the end of work arbor will almost invariably be bent, if the nut is pulled up tight upon a flat washer. The convex washer shown in cut is made of tool steel, which is hardened, having three V-points on the flat side. The back of the washer is convex to fit a concave-faced nut. This will allow the washer to adjust itself to any irregularity in the face of the blank without danger to the arbor.



USE OF CONVEX WASHER ON WORK ARBOR

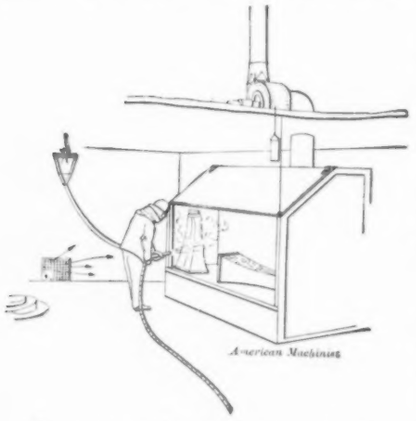
The accompanying cut shows this washer applied to a taper arbor, but there is no reason why it may not be applied for all such purposes.

New York. C. C. HOWE.

Arrangement of Air Draft for Sand Blast Equipment

The accompanying cut illustrates a system of air control for sand-blast outfit that has been developed by the American Blower Company in Detroit, Mich. A suction blower is placed over the box in which the sand blasting is done, to exhaust the air and fine particles of sand. The box is made no larger than necessary to contain the largest piece to be operated upon.

The principal feature of this arrangement is that the work is done in a closed room. Placed directly behind the operator and close to the floor is a grill, through which all air must enter the room, being drawn over and away from the operator; thus he has a constant supply of fresh air and escapes the greater part of the dust which otherwise would be floating in his locality.



SAND-BLAST DRAFT ARRANGEMENT

New York. C. H. LOGUE.

Round versus Rectangular Holes in Planer Platens

I should like very well to hear discussed the subject of round versus square holes in planer platens. I can learn of but one company which makes the platen with rectangular holes, and would like to hear the reasons other companies have for making the holes round. The rectangular holes seem best to me for the following reasons:

A 60-inch planer, as made by most companies, has 1¼-inch reamed holes for pins used in backing up the work. This hole has an area of 1.22 square inches. The same table, as made by the other company, has holes 1x3 inches, or an area of 3 square inches. The strength of the rectangular pin is almost 2½ times as great. One presents a curved, the other a plane surface to block against. I understand, of course, that a pin with a square head would be used, although some are made round. For blocking, therefore, the rectangular pins are decidedly best.

A platen with rectangular holes needs no T-slots. These slots, as every planer man knows, must be cleaned out before a new job is put on, if a full-sized bolt head is used. If a half head is used, the T-slot is soon destroyed, as innumerable ruined platens testify. Some will question the advisability of allowing chips to drop through the platen into the frame openings. Certainly, more drop through the rectangular holes, but on a 72-inch planer, running 70 hours a week, we find it necessary to clean out but once a month. This is done by a laborer after working hours, and the valuable time of the planer hand is saved.

With the rectangular holes, we use blocking pins and bolts to hold the work down. After the work is located on the platen, if the work needs to be fastened through some central opening, as is often the case, a bolt is dropped through, given a quarter turn and tightened up in any location. In the same case, with T-slots, the location of the bolts must be planned beforehand, and the work lowered over the bolts. Here, also, time is saved.

It will undoubtedly be claimed that the increase in area of the rectangular holes over the T-slots and reamed holes will weaken the platen. However, on a 72-inch planer, a 2-inch platen has never given any trouble although it has had hard usage.

The secret of good planer work is ability to properly fasten work to the planer. With rectangular holes there is no question of getting it on securely, either with wedges or straps, while there certainly is with round holes. We have timed a man fastening a piece on one machine with reamed holes and T-slots, and on another with rectangular holes, and find a saving of about 50 per cent. in favor of the cored holes.

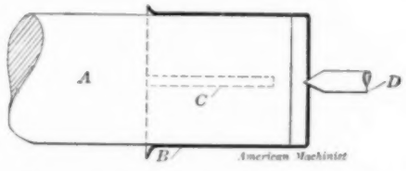
Practical, experienced men have too little to say regarding the designing of the machines they operate. If they had more voice in this, many details would be made more convenient, and I think there would then be rectangular cored holes in planer platens.

D. S. R.

Erie, Pa.

Simple Arrangement for Taking Speed of Shafts not Provided with Centers

Having occasion to take the speed of several shafts not provided with the usual centers, I had a brass shell *B* spun as shown and slotted at three equidistant points *C*. This was simply slipped on to the end of the shaft *A*, when the ordinary speed indicator *D* could be inserted in the countersunk hole in the end of the shell.



GETTING THE SPEED OF THE SHAFT

Waterbury, Conn. R. P. JAMES.

A Center Drill and Reamer

The halftone shows a center drill and reamer which I made for use in the lathe. The connecting rod is screwed tight in the reamer but can be unscrewed from the collar on the split chuck. This allows the chuck to spring open for adjustment of the drill. With this arrangement the center drill and reamer are there when you want them.

CENTER DRILL AND REAMER

H. H.

Kansas City, Mo.

Discussion of Previous Question

Jig Bushing for Close Centers

Eli Allison seems to take a long route to his sectional bushing, which he describes on page 1218, of the AMERICAN MACHINIST. The most objectional feature of his method appears in the riveting of the sections *a, b, c,* in his Fig. 4. Moreover, I do not think he gains anything by making the bushing in three sections, as he has done. His reason for this, as he says, is the proximity of the holes.

To make three bushings as he has described involves considerable time and labor, and I think the better plan is to drill the holes as shown in the accompanying figures. For work of this class I use a solder chuck, Figs. 1 and 2, clamping the work as shown. Planed stock of proper width, longer than the finished dimensions, is used, and after locating the holes, is cut off to requirements. Flat drills are best for work of this character. These are used with the open tailstock, cutting close to size and smooth, thus eliminating much lapping.

The work is first carefully centered, when there is no difficulty in starting the drill true. After drilling one hole the work is unclamped and moved the required distance along the anvil shown in the cuts, using a gage and stop. The substitute for the three sections, *a, b, c,* of Mr. Allison's article, as herewith shown, was drilled in this manner. All of the holes in this case are of the same diameter, but it is just as easy to drill a 0.07-inch hole in the middle.

Peering through the work after drilling each hole gives ocular proof of the truth of the holes, while the mechanical proof is shown by means of plugs and micrometer.

After hardening the bushing, it was again tested. No alteration of the center distances was detected. The only noticeable change was a slight expansion in the middle of thickness, which the micrometer showed to be less than 0.001 inch.

Elgin, Ill. GUS HAESSLER.

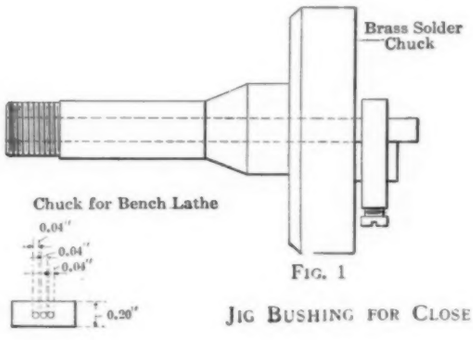


FIG. 1

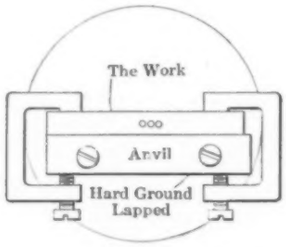
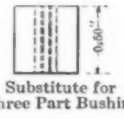


FIG. 2

JIG BUSHING FOR CLOSE CENTERS



Substitute for Three Part Bushing.

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

Cooperative Education

The University of Cincinnati coöperative system of education, described by Prof. Herman Schneider at page 148, fits the engineering student for his life work far better than the education obtained in the majority of colleges and universities. It seems clear from Professor Schneider's article that he fully realizes that hard work under shop discipline is of as much value to the student, in the development of character, as knowledge gained of shop methods.

Neither character nor the ability to do one's share in life's work is acquired by luxury or luxurious surroundings. Hard work alongside of men who earn their living with their hands brings out the latent man that is in a boy. It makes him see the serious side of life, it makes him learn the value of time, it teaches him thoroughness, it teaches him the advantages of an education. He sees men in the shop who, if given the advantages given to the student, would rise high in the engineering profession. It teaches him that there is always something to be learned from the man at the machine, and above all it teaches him to respect the man who works with his hands. A boy who has had such training will not be narrow or snobbish. He learns how little he knows—how much he has to learn. His experience will be of great benefit to him in dealing with men, particularly workmen, in after years.

I believe that the value of such a course in character building is greater than the value of the shop experience gained, although I by no means underrate the latter. I have felt too much the need of such experience to undervalue it. I also know by personal experience that to obtain shop experience of value the student must work in a commercial shop. I had the shop practice given at the United States Naval Academy, at Annapolis, and I know that the value of this experience is small. After graduation from the Naval Academy I had a two years' course in engineering at the University of Glasgow, which is situated in the heart of a prosperous engineering district. I availed myself of every opportunity to visit the best engineering works in the district, to study methods; but this did not give me the knowledge I needed—the knowledge that I should have gained at the same time that I was studying the theory of engineering.

Professor Schneider has ably described the need of a better, higher, more practical engineering education. Such an education cannot be obtained except by methods similar to those he has described, and if we are to keep our place in the engineering world, this education must be supplied by our engineering schools.

HOLDEN A. EVANS.
Naval Constructor, United States navy.
Seattle, Wash.

Making Small Grinding Wheels

In reference to the article by J. A. Phillips at page 219, on making small grinding wheels, I will say I have made such wheels from large wheels that were broken, by taking a stump of an old drill about 1/64 inch under the size that the hole is to finish and drilling in the drill press, running the machine by hand. This produces a good hole about to size.

In nine shops out of ten you will not find tubing, and when you do the chances are that it will not be the size you want.

I then mount my wheel on an arbor having a collar and nut and turn the wheel at very slow speed, using a high-speed steel tool.

It will surprise some to see how quickly a wheel can be turned in a lathe.

I also cut convex faces on wheels and they run well on the grinder.

New Britain, Conn. W. C. BETZ.

More about Scale in Hardening

Having read the article entitled "Prevention of Scale in Hardening," on page 864, Part 1, Volume 33, which had hardening and tempering rather mixed, I would like to explain a method I have used for over 10 years and that was old when I heard of it.

The dies used in jewelry and optical work, which must have a "glass finish," would require a lot of stoning and polishing if subjected to either sand blast, acid bath or cyanide.

The amount of labor is great that must be expended to give dies any kind of a smooth finish, that have been through any of these treatments. The amount of distortion is also great, especially in optical work, where one struck piece must miter with another piece.

In the case of a die, I first fill the matrix with powdered boracic acid and place it near the fire until the acid melts, which is below the coloring point of the steel. The blast must be watched, as too much will blow the powder away. After the first dose has melted, a little more should be added to make sure the matrix is entirely covered. The die can then be returned to the fire and hardened in the usual way.

The boracic acid will generally come off in the quenching bath, but in case it does not, placing the die, or other article, under a live-steam pipe will remove it. In case there is no live steam, boiling in water is just as good. It is seldom, however, that acid remains on the work unless too much was put on.

It is a very easy matter to polish the die, after this treatment, with flour of emery. I have used this treatment on very small taps and find they come from the bath clean in the bottom of the thread and ready for tempering. The color is not the same as on a piece of polished steel, but if one has several hundred taps to temper, of say 0.045 inch diameter, he can very soon get used to it.

Work that has been hardened and tempered by burning the oil off and which is generally black and covered with scale can be kept clean by the use of boracic acid, but it has to be steamed. Steaming not only removes the acid but also the oil.

The live steam is also a great agent to remove oil and emery after polishing a die.

Dies hardened with boracic acid seem to stand up as well as those hardened without it, and furthermore there is nothing poisonous about it.

Newark, N. J. F. CHES.

Transfer Templets

In several recent issues of the AMERICAN MACHINIST, articles have appeared on the use of celluloid for templets to be used in laying out standard parts. A modification of this principle may be carried out in cases where the same

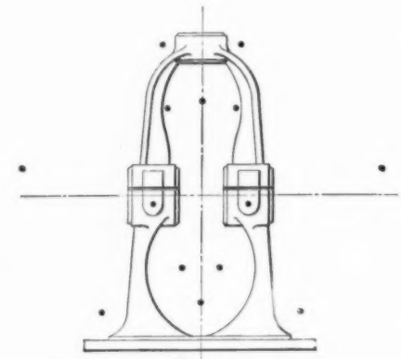


FIG. 1

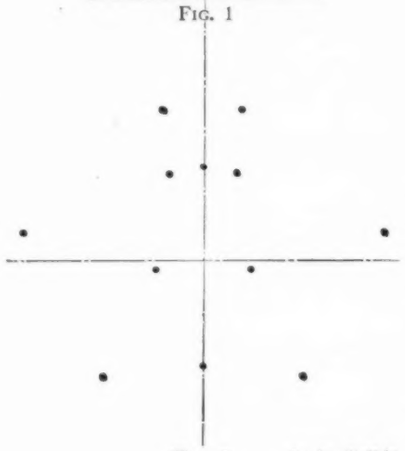


FIG. 2 American Machinist

TRANSFERRING DETAIL BY TEMPLET

part, or group of parts, appears in several positions on a drawing, but instead of celluloid, using ordinary detail drawing paper. The method is as follows:

After drawing in the part, or group, in one position, slip a piece of detail paper underneath the centers to be transferred. Punch these centers through drawing and underlying paper and withdraw the templet. It may then be completed, ready for using, by drawing through any points on center lines, these to be used for the purpose of locating templet in the several positions to be shown. The templet should be trimmed for convenience to as small a size as will just include all centers and the locating lines should run to the edge.

Draw lines in the several positions on the drawing corresponding to the locating lines on templet; locate and punch through into drawing, all centers required and fill in. The compasses can be set to proper radii from the original view and used consecutively on all others. Straight lines can then be filled in.

Fig. 1 shows a detail that was treated in this way for four different locations. Fig. 2 shows the templet. Not only was a saving of time effected, but also the number of construction lines were kept to a minimum.

Bethlehem, Penn. J. K. M.

Why Gear Hobbing Machines Cut Flats

George B. Grant, in his interesting article on the above subject, which appeared in the AMERICAN MACHINIST, page 1148, Volume 33, Part 1, is rather severe on the makers of gear-hobbing machines for not pointing out their defects as well as their advantages. The latter well known and of great importance. It is generally admitted that a wheel can be hobbed in from one-half to one-third the time taken to cut the teeth by a single rotary cutter, and also that the spacing of the teeth in a hobbed wheel is more perfect than can be obtained by any other process.

I think that the makers may be excused for not pointing out the existence of the flats, for these are so extremely minute that it is only within the last few years that they have been noticed at all. After a hobbed wheel has been run for a few hours, the ridges between the flats are all worn down and the wheel is then the best that can be obtained. However, in justice to the firm of Humpage, Thompson & Hardy, of Bristol, makers of high-speed gear-hobbing machines, may I ask Mr. Grant to refer to my article on "A Hobbing Cutter for Finishing Wheels," in the AMERICAN MACHINIST, Volume 32, Part 1, page 126. In that article I went into the question of the flats and gave the explanation of them in almost the same words that Mr. Grant has used.

I also showed how, by increasing the number of cutting blades in the hob, the number of flats is increased and a closer approximation to the true involute curve could be obtained, and I then proceeded to describe the Humpage patent hob with inserted blades for finishing wheels. Some points which were raised in connection with that article were fully answered in my article entitled "Some Points in the Hobbing Process," which appeared in the AMERICAN MACHINIST, page 168, Volume 32, Part 2.

The theoretically perfect hob has an infinite number of cutting blades. If we substitute a worm of abrasive material for the hob, we have what is practically a hob with an infinite number of cutting points. Mr. Humpage has recently

patented a machine in which wheels can be finished by grinding the teeth all over with an alundum worm which meshes with the teeth, and is fed down through them just as the hob itself is done. In this machine the thread of the alundum worm is made slightly thinner than a tooth space, so that one side of the teeth is ground and finished before the other side is touched. The idea is that wheels should be roughed out on the hobbing machine and finished on the grinding machine after hardening. Half the trouble experienced by motor-car manufacturers is due to the fact that their wheels go out of truth in the hardening.

Moreover, in turning operations it is found economical to take a rough cut on the lathe and finish on the grinding machine, and there seems no reason why the same should not apply to gear cutting. The wear on the alundum worm is found to be very slight, but to reduce it as much as possible, the wheel that is being ground is made to traverse across the face of the worm by a differential mechanism. A corundum wheel is also provided for truing up the alundum worm.

It must be understood that this is a refinement for motor-car manufacturers only. For all other work the hobbed wheel as it leaves the machine is sufficiently good.

Personally, as a practical motorist, I am unable to understand why so much time is spent on striving after a noiseless gear box when efforts should rather be directed toward doing away with the gear box altogether. As long as toothed wheels are employed there will be noise. My own car is by one of the best makers, and the gear wheels are cut on a Fellows gear shaper. On the direct drive the car is almost noiseless, but directly the gears are used, the noise is very considerable.

P. A. THOMPSON.

Bristol, England.

Mounting Car Wheels

The recommendations contained in committee report on "Mounting Pressures for Car Wheels," page 225, should result in much better work than some that has been turned out of the best car and locomotive works in the country. The only shop term, known to the writer, that describes the finish often left on wheel fits of axles and in wheel bores is "Washboard finish." Let us trust that less of it will be used as the years go by.

While it is clear that the gages described in the above paper could be used for car-wheel work, it is not easy to understand why one should go to so much expense to change commercial micrometers into gages as inconvenient as these appear to be.

Such gages may be used by a "checker" after work is complete, but certainly would not be chosen by a workman on lathe or boring mill.

The two principal objections to these gages seem to be their inconvenience and inaccuracy: inconvenience resulting from their size and form, inaccuracy from the impossibility of verifying one's "touch."

If the surfaces measured were perfectly smooth and free from dirt and metal particles, the click of the ratchet *might* be depended on as final; but I believe most experienced gagers will prefer to verify the touch obtained, by sliding the contact point across the place of contact.

While it is possible to buy micrometer heads on the market, the writer has never seen such a one as shown at Fig. 3, with reverse graduations and a rounded contact point. Possibly such may be on the market, but the belief is very strong within me that the same nimble apprentice that made the high-speed record with the tool shown at Fig. 3 would have made better time with a plain inside micrometer and have been more sure of his sizes.

WM. S. ROWELL.

Morton Park, Ill.

Is There Any Best Machine Tool?

It seems to me after reading Osborne's article on page 1196, Part 1, Volume 33, that he has no case so he tries to make one. By accusing me of having possibly thought that I knew how to select the best tools he sets up a straw man having the same general features as Entropy and proceeds to beat him to a pulp. Now I wish to submit the following: First, a confession; that for a period of about 10 years and for purposes of publication only I knew perfectly well that the one best and only best lathe on the market was one that I was looking after, building in the shop.

Second, brother Osborne's text is built on this question (page 786, Part 1, Volume 33.) "In a shop running on jigs and dies how many could pick out the best 48-inch planer?" He does not answer the question.

Third, by inference I answered it by practically saying, "no one."

Fourth, by inference Brother Osborne sidesteps the question by inferring that Entropy doesn't know. Now barring the said aforementioned ten years, since which I have reformed, I freely admit that Brother Osborne is right.

Finally he is entirely wrong, as every man who buys a machine tool has a chance to pick out the best and I believe usually succeeds. In other words Mr. Osborne is talking about one thing, and that something so self evident as not to need discussion while I am talking about something else.

Mr. Osborne's position, by inference, is that no one machine tool is best for every where, which we are all willing to admit.

My position is, by inference, that for every place where a machine tool is needed there is a best tool and that the man who has the responsibility for its purchase is entitled to more light on the character of the various tools offered than is usually given him. The sale of machinery is based on the personality of the opposing salesmen more than is good for the purchaser. Anything which shows up the merits or demerits of the machine is worth more than long cigars or liquid refreshments, to the purchasing firm.

When Mr. Osborne looked up that list of 52 engine-lathe builders who advertise in the AMERICAN MACHINIST he was not looking for the best lathe in the sense in which he is talking. He was looking for the best lathe for his particular conditions and that is a very much narrower set of conditions. I see he narrowed down to four right off. Probably if the salesmen with their inducements had stayed away and merely submitted *facts* about their tools he could have picked out *his* best machine in an hour and I might have done the same and gotten a different tool and both of us might have been right.

Then Osborne contrives to find me lacking in faith in the men in the shop. In order to do so he has to forget entirely what I really said, which was: "It is surprising how many men there are, who have risen from the bench and lathe to be heads of their own shops, who do not know anything about any tool *except the one they have run most.*" Mr. Osborne scoffs and then admits that he depends on the judgment of his men as to the tools that they have run more than he.

As for the range of three to one in the prices bid on a lathe I wish to say that this is an actual occurrence and on bids for a United States Government shop where bonds were required for the fulfilment of the contract. Needless to say the specifications were the same for all.

I can go still further and cite another case on a government contract where the specifications were so drawn as to practically confine the bidding to the lathe which I was then building. In fact they were drawn in my office and no other lathe was submitted. There were six bids and the range was from $400 to over $600. Our price to dealers in the open market was $450. The lowest bidder got it and filled the order and paid us the $450 and threw in a chuck for good measure.

I trust that Mr. Osborne will not have the temerity to name any lathe, planer or gas engine as the best in the market, except the one that he builds in which case he will be acquitted if he pleads *dementia Americana*, for we all do that, but I trust that he will not quote me as doing it or offering to do it until I do.

If on the other hand he wishes to buy a lathe and the builders will submit to him a full statement of facts such as I really suggested I believe he will be willing to thank them for the service.

ENTROPY.

The Papers and Discussions of Engineering Societies

The editorial at page 1129, Part 1, took my mind back to some five years ago, when I read a paper before a prominent engineering society.

My experiences were such that I made a vow never to repeat the offense, for I have a distinct recollection of my youthful days and a copy-book heading to the effect that "What is worth doing is worth doing well." All through my life I have tried to frame my actions on the principle that is embodied in this phrase and tried to carry out this matter in the same spirit. At the reading of the paper there were several individuals present who had evidently come there with the direct intention of exploiting their, or their employer's wares, while I, in my innocence, had taken especial pains to abstain from this offense. I should have said that the paper was written some weeks before the reading of it, was printed and circulated among the members of the society so as to give them ample time to digest its contents and prepare any possible criticism.

I read my paper at the appointed time with the kind of stage fright which affects me on these occasions, and was asked a multitude of questions; these of course wanted replying to, but the gentlemen who had the ordering of the arrangements limited my time to some three minutes for this very essential thing. As a matter of fact, it was nearing lunch time and apparently the claims of the stomach were of more interest than any discussion arising from my poor paper, while to add to my embarrassment the chairman of the meeting in a series of stage asides begged me to hurry up and said that I should have opportunity of answering the questions in the printed minutes of the association. Now, as I gave time and effort for the benefit of this association I consider that I am entitled to criticize the actions of this and kindred societies, and I do not think their methods the best that could be followed for educational purposes.

The real benefits from any paper, be it either written for publication or orally delivered, lie in the discussion it gives rise to, and it seems both foolish and discourteous to curtail such discussion. If these conferences are really got up for the exploiting of engineers' wares, then let us be honest and call them "engineering exchanges" and not "conferences." That this particular paper was of deep interest was proved by the many pertinent questions which were asked, and a discussion of them and the possible solving of a few problems would have benefited both myself and my audience, but the prearrangements defeated the object and I came to the conclusion that there was too much of the "cut and dried" about the arrangements that had been made. I am well aware that some safeguard is required against those who are inclined to be too prosy, but on the other hand it seems absurd to fix a time limit to a subject when it is impossible to foretell the amount of discussion it may give rise to.

DEMONSTRATOR.

Coventry, England.

Prevention of Scale in Hardening

In the discussion columns, on page 83 of the AMERICAN MACHINIST, George T. Coles states how to prevent scale when hardening.

Scale is not produced in tempering but in hardening, as then it is necessary to raise the temperature to about 1500 degrees.

Using the oil bath for tempering would not prevent scaling, if the ordinary methods in heating were employed. The advantage of the oil tempering bath is that the temperature can be exactly controlled and known.

Moreover, it is not necessary to closely watch the article during the tempering. It can be thrown into the tempering bath and left, and then withdrawn when the hardener pleases. The temperature of the steel cannot rise higher than that of the bath.

When tempering on a hot plate the only guide the temperer has is the color due to oxidation of the surface. If the piece is neglected its temperature will run much higher than that required and the piece may be spoiled.

H. D. CHAPMAN.

Washington, D. C.

That Air Cooled Emery Wheel

I have read S. H. Merrill's letter at page 132 and wish to state once more that the wheel described by me at page 1073, Part 1, Volume 33, is for grinding delicate work, not for grinding off castings or high-speed steel. Delicate work might be grinding the needle for the "needle gage" used in measuring the holes in watch jewels—say, 0.004 inch diameter at the small end and about 1 inch long.

How would a 46 N wheel go on this job? At any rate the wheel which has done the trick was a 150 grade 2¼. The air gaps prevented burning the work and the fine wheel left them in good condition to finish with the lap.

Then let us consider the reamers; they might be made of high-speed steel and the cutters also; but we need a finer edge on ours than a 46 wheel will leave, so we use 60 and 80 grain, but grade *N* is a pretty hard wheel; *K* is better, or even *H*. With grade *H*, when grinding teeth on a cutter, the air gaps in the wheel will avoid drawing the temper in the fine edge. Many special reamers, with two sizes, require grinding to a corner. A wheel hard enough to do the trick would draw the temper. The grinding of snap gages requires a wheel hard enough to hold its shape and fine enough to give a good finish; the air gaps solve the problem successfully.

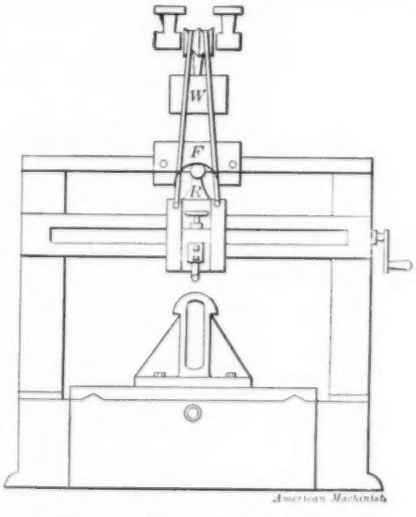
Mr. Merrill speaks of hacking the wheel to true it, which shows he did not understand the principle. The idea is to grind in generous air gaps (the periphery or face of the wheel to be trued with a diamond held in the usual way), and is not by any means advocated except in cases where the regular wheels will not do.

Athol, Mass. W. H. SAWTELL.

How to Machine Those Pieces on a Planer

The cut shows how to successfully handle Tynsider's job (page 1220, Volume 33, Part 1) on a planer.

The rig is a "copying" one with a former *F* bolted to the top rail, the tool box is allowed to run freely and has a



HOW TO PLANE THOSE PIECES

copying roller *R* to follow the former *F*. The roller is kept in contact with former by two wire ropes onto the overhead rig weighted by *W*.

The tool is then fed along horizontally in the usual way, using a fine feed and broad-pointed tool to finish.

This system has been used by me, on a half ellipse and there is no reason why it should not make a good enough job in this case.

London, Eng. R. L. HASELGROVE.

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American Machinist

Editorial

Mutual Liability Insurance

One probable effect of the workingmen's compensation acts, which went into effect in this State, September 1, has not received the attention that it deserves. We refer to the stimulus which it should, and undoubtedly will, give to the movement for the organization of employers' mutual liability insurance companies.

The soundness of mutual insurance is thoroughly demonstrated. To say nothing of the vast structure of life insurance which in most companies is essentially, and in many of them, including the largest, absolutely mutual, the mutual fire-insurance companies have shown that there is no need for the intervention of outside capital in these matters. So long as the relation between the insured is not such as to lead to community of action, as, for example, in accident insurance, which deals with individuals having no interests in common, the insurance company of the traditional type is the natural, and, in fact, the inevitabile method of solving the insurance problem. When, however, the insured have common interests and are already associated through organizations of various kinds, and when a given line of insurance reaches a degree of importance which justifies concerted action, then the mutual system finds an appropriate field.

There is no field in which this condition is more clearly manifest than that of liability insurance, and we regard the formation of liability-insurance companies as inevitable in the near future. From another point of view the mutual system is more appropriate to this field than to almost any other that can be named, and with the increased importance of the subject, due to the new laws, the formation of mutual companies is almost a foregone conclusion.

There can be no doubt that the existing liability-insurance companies are directly responsible for much of the agitation that has brought about the new laws. Their absolute heartlessness in their dealings with the sufferers from industrial accidents has, beyond all doubt, had a powerful effect in bringing about the demand for new laws by workingmen and their organizations.

On the other hand, now that figures are available showing the small percentage of the premium receipts which the companies pay out in indemnities, employers have a grievance that is only less than that of their employees. The premiums paid by employers, when compared with the results in indemnity payments, have led to a condition of dissatisfaction which makes the time ripe for the organization of mutual companies.

The insurance companies are already threatening an advance of rates, which, indeed, would seem to be inevitable. The large margin which exists between the premium rates and the indemnity payment suggests at once that much and perhaps all of this increase can be avoided by the organization of mutual companies. Of course, the actual figures can only be known after experience has accumulated, but there can be no question that this large margin will provide important savings.

There can also be no doubt that the increased liability of employers will lead to increased attention to safety devices, and to increased vigilance in their use after installation. The liability of employers in cases of accidents has now reached a degree of magnitude which compels attention from both the standpoints of prevention and insurance. To what degree the bad record of this country in the matter of accidents, and the worse record of the insurance companies in the matter of indemnity payment, can be improved remains to be seen. We believe, however, that improvement will follow, and with greater care in the installation and use of safety devices, and the organization of mutual insurance companies, we do not believe that the increased cost to the employer will prove to be as serious as many fear.

Antediluvian Apprenticeship Contracts

It seems hardly credible that the apprenticeship contract, quoted in part on another page of this issue, or the laws which make imprisonment the penalty for disobeying it, are part and parcel of this day and age. And Judge Tappan is to be commended for his condemnation of both the contract and the laws which might have made its enforcement possible.

When we contrast this with the contract of the National Machine Tool Builders Association, or that of the New York Central Lines, and see what both are endeavoring to do in the way of supplying educational advantages in addition

to the shop training, we wonder that any boy's father would sign such a contract as we quote. The chances are that he may have been employed by the same company, or that he felt obliged to do so by force of circumstance, rather than by natural inclination.

Such one-sided contracts cannot help but arouse the spirit of antagonism in every boy, nor fail to breed inharmony and discontent in nearly every case in spite of the bare possibility of the princely gift of twenty-five dollars, when the boy has completely subjugated himself for four long years.

As a matter of fact, many employers are beginning to doubt the wisdom of attempting to hold boys who want to leave their employ. Unwilling service is never satisfactory in any way. The advantage of a contract is that, instead of throwing up his job because the boss had a grouch, due to cold pancakes for breakfast, they both get a chance to cool off and become natural again, instead of breaking off diplomatic and other relations on the spot.

This might also be accomplished by inserting a clause to the effect that the contract could be terminated on thirty days' notice. A boy who can quit in thirty days will not be nearly as apt to want to leave as though he thought he couldn't without some kind of a row. This is probably because he is so much like the men he works with and for.

The Difficulties of Lead Manufacturing

Some idea of the difficulties of running a smelting plant, as well as of the unpleasantness of the work, can be had from the reports of two smelting plants mentioned by Doctor Hamilton in a report on lead poisoning in Illinois. One loses from 5 to 50 per cent. of its men every pay day, or every two weeks, while another loses 25 to 30 per cent. each month.

This means that gangs of new men have to be taken and that there is a constant movement of men more or less affected with lead poisoning, into other industries.

No manager can study these statistics without being impressed by the great drawback of such rapid changes in the working force. And almost any cost which would enable men to work continuously as in other trades, would seem to be justified by economy alone.

The whole problem is a difficult one, for we could hardly do without lead products, yet none of us care to think of it as necessarily fatal or even injurious to the workers. We believe that there is enough humanity and brains in the country to find a satisfactory solution of the problem.

New Publications

Dimensions of Pipe, Fittings and Valves. The National Book Company, Collinwood, O. 75 cents.

This useful little book has reached its third edition and now contains 80 pages of 6x9-inch size.

Simpson's Manual of Screw Cutting. Forty 2½x6-inch pages, with 11 illustrations and numerous tables. Woodbury Publishing Company, Boston. Price, 50 cents.

Those who feel the need of a compact manual of screw cutting, either for the purpose of study or reference, will find in this booklet all that they require and in sufficiently compact shape to make it suitable for carrying in the pocket without becoming a burden.

Practical Dynamo Building for Amateurs. By Arthur J. Weed. 81 5x7½-inch pages, with 64 illustrations. The Norman W. Henley Publishing Company, New York. Price in paper, 50 cents; in cloth, $1.

As the title indicates, we have here instructions for building and winding a small dynamo. Dimensioned working drawings are given for each piece of machine work, and the operations of winding are shown by several halftone illustrations. The capacity of the machine when used as a generator is 50 watts; when used as a motor it is able to drive a small drill press or lathe.

The Steam-engine Indicator. By F. R. Low. 169 6x9-inch pages, with 144 illustrations. The McGraw-Hill Book Company, New York and London. Price, $1.50.

Mr. Low's book on the indicator is too well known to need an extended notice on the appearance of a new edition of it. Every useful phase of the instrument is discussed in a clear and plain manner which leaves nothing to be desired. Several tables which are useful in connection with calculations based on indicator diagrams are included, together with an extremely convenient transparent chart of theoretical extension curves. Extended attention is given to diagrams from compound engines, and a lengthy chapter relates to errors in the diagrams, due to faulty reducing motions, undue length of indicator piping and other causes.

The Marine Steam Engine. By the late Richard Sennett and Henry J. Oram. Tenth Edition. 502 6x9-inch pages, with 414 illustrations. Longmans, Green & Company. London, New York, Bombay and Calcutta.

Since the death of Mr. Sennett, the revision of his great work on the marine steam engine has been placed in the hands of Mr. Oram, whose work was begun with the third edition, which appeared in 1898, and his revisions have now been so extensive, because of the rapid progress in marine-engine design, that little of the original author's work remains.

While extensive revision of such a work, from time to time, is necessary, we regret to see that the reviser has seen fit to omit much of the original contents which made the book a manual of design, as well as a treatise, which latter it has now come to be almost exclusively. As such it retains, and even improves upon, the merits of the original book, but we believe that others, with ourselves, will regret the omission of much that they formerly found of immediate use in the drawing office.

Personals*

Charles H. Coe, formerly with A. Z. Boyd, is now in charge of the New York office, 90 Centre street, of the Wells Brass Company, of Greenfield, Mass.

F. M. Schiffmacher has been appointed manager of the engineering and experimental department of the Olmsted-Flint Company, 136 Liberty street, New York City.

James W. Thomas, formerly with Westinghouse, Church, Kerr & Co., is now mechanical engineer for the New England Engineering Company, at 50 Church street, New York City.

Edward J. Kunze, formerly consulting engineer, New York City, has been appointed assistant professor of mechanical engineering at the Michigan Agricultural College, East Lansing, Mich.

Clifford Talbot, formerly with James Cunningham, Son & Company, Rochester, N. Y., has accepted a position as superintendent of the Seldon Motor Vehicle Company, of Rochester.

John A. Doane, formerly superintendent of machine shops for the Taylor Iron and Steel Company, High Bridge, N. J., has severed his connections with that company to become the superintendent of machine shops for the American Optical Company, of Southbridge, Mass.

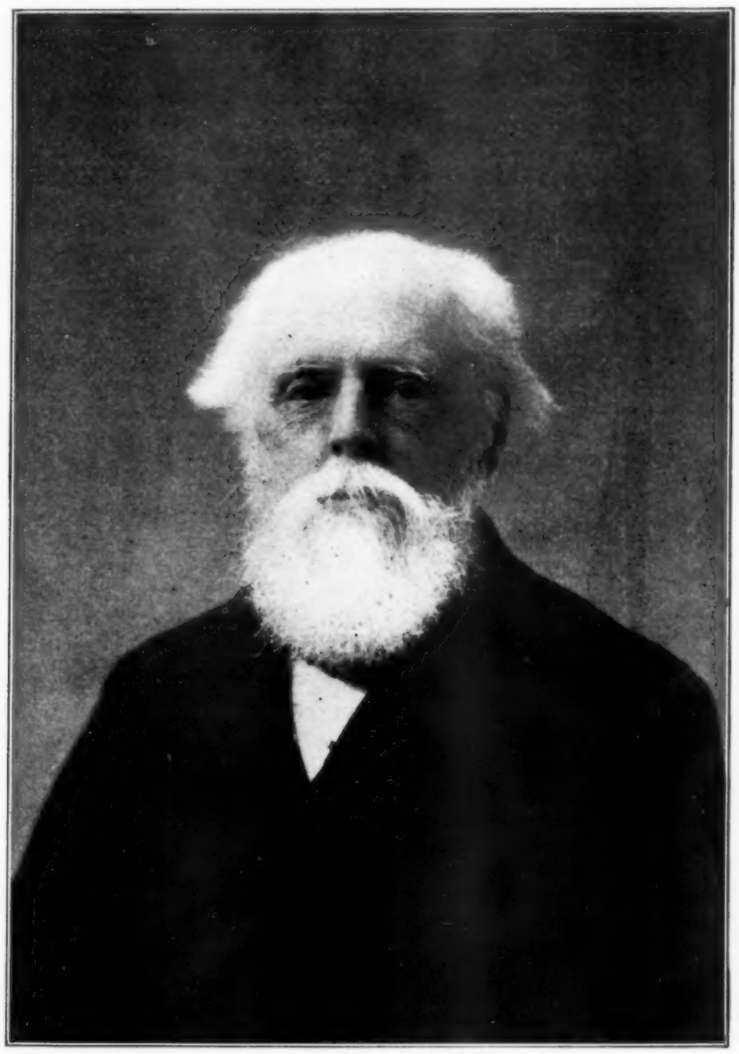
Charles F. Kenworthy, until recently with the engineering department of the American Brass Company, and formerly of the Kenworthy Engineering Company, has been engaged by the Rockwell Furnace Company, to represent it in the New England States and Canada. Mr. Kenworthy has devoted his entire time for the past eighteen years to the design and construction of furnaces and fuel apparatus.

The Commissioner of Patents, in his last report, recommends the repeal of the section of the patent law providing for the filing of a caveat. This is only effective for one year and costs nearly as much as a patent application which affords more protection.

*Items for this column are solicited.

Charles Talbot Porter

On August 28, at his home in Montclair, N. J., Charles Talbot Porter passed away. He was born on January 18, 1826, at Auburn, N. Y. All that heredity could do for a man's brains was done for his. On his father's side he was a great-grandson of Jonathan Edwards, while through his mother he was descended from such New England families as the Phillipses and Winthrops. After graduating from Hamilton college, in 1845, he read law in the office of his father, Hon. John Porter,



CHARLES TALBOT PORTER, FATHER OF THE HIGH-SPEED ENGINE

and thereafter practised for several years in Rochester and New York City.

The college instruction of that day had taught him rather worse than nothing about mechanics, which proved to be his natural bent when he found it out. He soon acquired a disgust with the law, at which his clients seem to have been more proficient than himself. One of them beguiled him into a venture with a "centrifugal-force engine"—his first engineering experience—and another unloaded on him the patent of a stone-dressing machine. This machine, while impracticable as it stood, contained the germ of a good idea. Mr. Porter went to work to improve it, picking up by the way a knowledge of drafting and designing, and therein brought out his latent mechanical faculty so well that the machine proved a technical success and made its way commercially until the practice was introduced of sawing out, instead of dressing, the building stones for which it was intended and that fact destroyed its usefulness. The stone-dressing machine had been driven by an engine which governed faultily, to remedy which Mr. Porter was led to the design of his well known central-counterpoise governor (patented 1859). Into the manufacture of this he entered, equipping a shop in New York for the purpose. In 1861 Mr. Porter patented an isochronous centrifugal governor for marine work, which made its début on the German Lloyd steamship "New York," where it received high commendation. Previous to that time the engineers had been obliged to throttle their engines by hand.

THE BEGINNING OF THE HIGH-SPEED ENGINE

About this period, Mr. Porter called on a New York firm of hatters in relation to their steam plant and there fell in with their engineer, John F. Allen, who showed him the design of a variable-cutoff valve and gear that he had worked out. It was agreed that they should attempt to apply this valve mechanism in connection with Mr. Porter's governor to a high-speed engine, and thus the Porter-Allen engine had its inception.

The indicator was then little used in America, and one adapted to high-speed work was not obtainable. At this juncture, and at the instance of Mr. Porter, Charles B. Richards designed his first indicator. Mr. Porter bought the patent. An instrument for testing the spring was devised by him. With the success of the engine elements thus far brought together, Mr. Porter set himself to making improvements in details of design—cranks, journal boxes, eccentrics, etc.—and he prepared an 8x24-inch engine for the London International Exhibition of 1862. This was made to run at 150 revolutions per minute, since he justly apprehended that a speed of 200 revolutions would frighten people.

As Mr. Porter sailed for England to look after his exhibit, there occurred the Mason and Slidell incident which brought that country to the verge of war with the United States, and when he arrived he found that the space allotted to American exhibits had been confiscated. However, he was permitted to install his engine to drive some looms, in place of one that had failed, though with the proviso that he should not exceed a speed of 120 revolutions. But the engine ran so smoothly that the speed limit was removed. After some time, the engine was sold to drive a foundry blower at high speed. The indorsement implied by the purchase helped to convert the apathy with which it had been received in England, because it was noncondensing, into a wave of interest and appreciation.

BUSINESS IN ENGLAND

British orders for governors now began to come in. Mr. Porter busied himself with the standardization of the Richards indicator and its manufacture in England, one application being to locomotive service, on which subject he

read a paper at Newcastle in 1863, before the mechanical section of the British Association for the Advancement of Science. Improvements in the bed and other features of the engine also occupied him, and he applied the engine to condensing service, soon designing a high-speed air pump for this purpose. He had, in fact, entered upon quite a protracted sojourn in Great Britain. Arrangements were made with Ormerod, Grierson & Co., of Manchester, for the manufacture of the engine.

Upon the insolvency of Ormerod, Grierson & Co., he was approached by the Whitworth company, which informally took up his engine and set about constructing one for the Paris exposition of 1867. Mr. Porter's acquaintance with Whitworth led to curious obscurations of personality and practice. A proposed written agreement with him failed of execution because of the demanded incorporation of a privilege for Mr. Whitworth to alter the engine at discretion. To this Mr. Porter dared not consent, fearing the result of Whitworth's aggressive individuality in a field new to him. In 1868 Porter read before the Institution of Mechanical Engineers a paper on the Allen engine which led to an animated controversy over piston acceleration, the actual rate of which Mr. Porter was the first to point out.

Return to America

Mr. Porter's English residence now drew to a close. Having received from his friend, George T. Hope, president of the Continental Fire Insurance Company, of New York, an encouraging offer of financial support if he would return to the United States and join Mr. Allen in the manufacture of the engine, he set about the plan of a model shop to be arranged substantially in accord with one designed by Smith & Coventry, near Manchester, Eng. It was a type with nave, two-story side bays and traveling crane. He returned to America in June, 1868. His little governor shop on West Thirtieth street, New York, had been kept running during his absence.

Upon reaching America, Mr. Porter found that the financial backer of the enterprise on whom Mr. Hope relied had leased a small building in Harlem and provided Mr. Allen very inadequately with funds for its equipment. Mr. Porter succeeded in obtaining from him some additional capital and started work. Before the end of the first year, the unnamed capitalist before alluded to proposed the formation of a stock company. He was allowed a controlling interest, became president and is charged by Mr. Porter with serious mismanagement. Resistance to his unwise policy brought Mr. Porter to the verge of ouster for insubordination, though the situation was temporarily saved by Mr. Hope, who bought out the control. But the expiration of the lease on the shop, coupled with a lack of confidence on the part of capital anticipatory to the panic of Black Friday, 1873, forced a closing out of the business. Just at the end, an engine was built for the Clinton Wire Cloth Company, whose work peculiarly demanded high speed and uniformity.

Two engines had been exhibited at the American Institute fair, New York, in 1870. In their report, the judges, President Barnard, of Columbia, and Thomas J. Sloane, proposer of the gimlet-pointed screw, said: "The performance of the engine is without precedent."

Manufacture of the engine was suspended from the spring of 1873 to that of 1876. This interval Mr. Porter improved by revising and standardizing its design. Resumption of construction work was effected by an arrangement with Mr. Phillips, surviving member of the firm of Hewes & Phillips, Newark, N. J. In spite of a lack of ready money the construction of engines was carried on successfully.

At the Centennial Exposition, Philadelphia, 1876, Mr. Porter acted as a judge in coöperation with Professor Reuleaux, of Berlin, Horatio Allen, formerly president of the Novelty Iron Works, New York, and others. This furnished opportunity for some curious experiences and some caustic comments on human nature as well as on mechanical art. Mr. Porter took delight in describing to Professor Sweet the diminutive engine of his type that would equal in output the famous Corliss engine at the Centennial.

The Tabor Indicator

A 6x12-inch engine, to make 450 revolutions, was built for a bone-pulverizing mill at Newark, N. J., and on this engine was tried a new indicator invented by a young man who introduced himself as Harris Tabor. The diagrams proved free from such vibrations as the Richards indicator would produce at that speed, and with a certificate from Mr. Porter stating the conditions under which the cards had been taken, Mr. Tabor started for Boston to see Mr. Ashcroft.

Removal to Philadelphia

Before many years, the business had outgrown the Hewes & Phillips works and with Mr. Hope, who had an equal interest in it, Mr. Porter discussed the formation of a company with $800,000 capital, offering to assign his patents for $100,000 in stock. The Southwark works, Philadelphia, of the old engineering firm S. V. Merrick & Sons, were in the market for sale, and, impressed by their appearance, Mr. Porter advocated their purchase. The Southwark Foundry and Machine Company was now organized for this purpose though Mr. Porter had supposed that it would be called the Porter-Allen Steam Engine Manufacturing Company. From the start he began to meet disappointments premonitory of the obstacles later offered to his guidance of the work.

Earlier in that year, 1880, he had participated in a meeting at the office of the American Machinist, at which it was determined to organize the American Society of Mechanical Engineers, and at its first session, held in Stevens Institute, he had read a paper on the strength of machine tools. Various engines were now being turned out, but difficulties of one sort or another met Mr. Porter at every turn, the chief obstacles being those within the works, where, in spite of the responsibility placed upon him for results, his ideas were disregarded both by those above and below him. As between him and the president, the directors chose to sustain the latter, and Mr. Porter's connection with the establishment ceased.

Subsequent to retirement from connection with the manufacture of the engine that bears his name, Mr. Porter lived to spend a long and honored portion of his career, practising the engineering profession in New York City, while he resided at Montclair, N. J. Ill health, resulting from an accident, forced him to abandon work at times, but generally he was active and alert in spite of his advanced years.

Literary Work

Mr. Porter was the author of "A Treatise on the Richards Steam Engine Indicator and the Development and Application of Force in the Steam Engine" (1874), and of a work of more general character, "Mechanics and Faith" (1885), in which he ably showed why he, a man of science, could none the less accept as true things which belong to a higher realm than that of the senses.

At the instance of the editor of *Power*, Mr. Porter wrote a most interesting series of "Engineering Reminiscences," which ran in that paper and in the American Machinist during 1903 and 1906, suspension through the interval being occasioned by Mr. Porter's health. They were later published in book form.

As a writer, Mr. Porter was possessed of a graceful, accurate and attractive style, which apart from knowledge of his history suffices to stamp him as one of the men of old-school culture who are not now found so frequently in the engineering profession as at a time when education for mechanical pursuits was less specialized.

The story of his life constitutes a history of the rise of the high-speed engine, of which he was the unquestioned father. In recognition of his work in this field he was, in April of last year, awarded the John Fritz medal.

Pressing Automobile Frames

Editorial Correspondence

A plant devoted to the production of pressed steel automobile frames, showing the heavy power presses used.

The Hydraulic Pressed Steel Company, of Cleveland, Ohio, is devoted almost exclusively to the manufacture of automobile frames, with 450 men engaged in this work. They handle about 18,000 tons of steel each year; the output approximates 100,000 frames.

Fig. 1 shows an 8000-ton toggle press used for blanking the side frames, the steel having first been cut to the proper width on a shear. The toggle press is sunk into the floor to facilitate the handling of material. It will be noted that the top die is made flat, so as to produce a straight stamping. The necessary shear is all in the lower die, being made in sections, as is shown by the crimped appearance of the trimming lying over the truck at the right of the cut.

Fig. 2 is a front view of the toggle press as it was first assembled for testing. Fig. 3 is a rear view, showing the driving mechanism, which is under the floor in Fig. 1. The operation of the press will be apparent from these views. This press was built by the E. W. Bliss Company, of Brooklyn, and operates at the rate of four strokes per minute. The bed area is 48 x 92 inches. This press is also used to bend the side frames, although this is usually done on a heavy hydraulic press (not shown).

The press shown in Fig. 4 weighs 200-000 pounds, and has a capacity of delivering a blow of 5000 tons at the rate

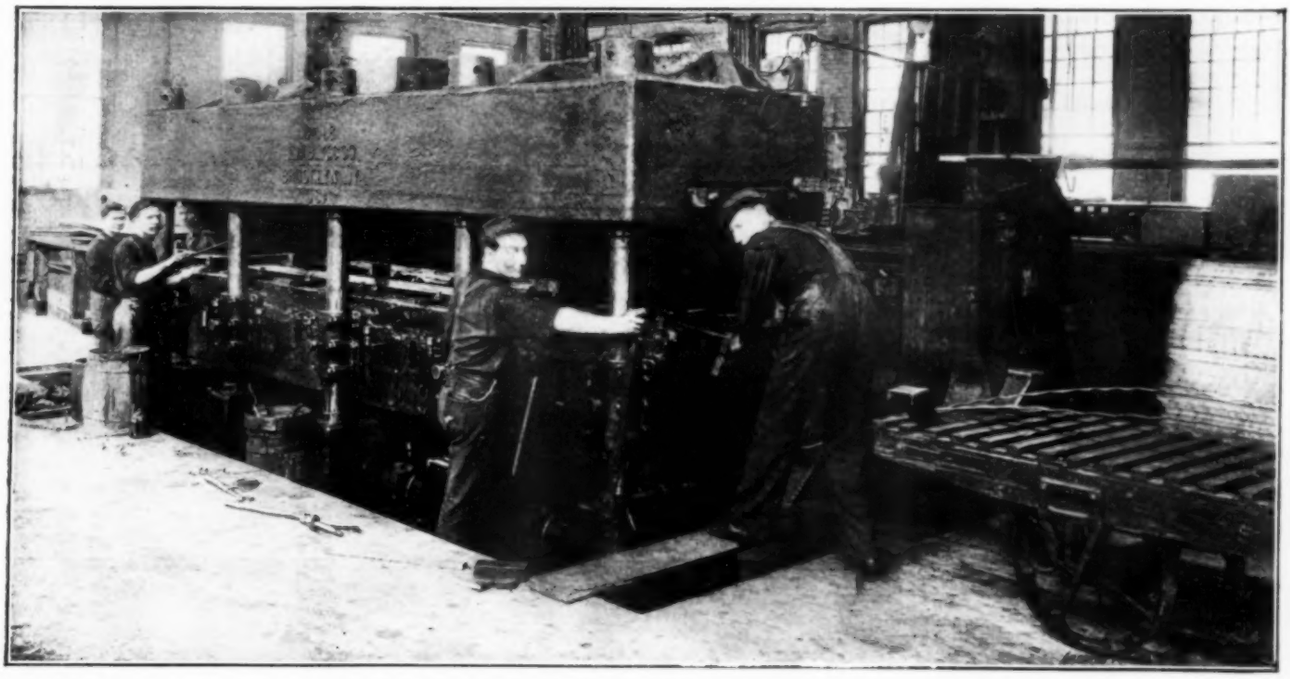


FIG. 1. BLANKING THE SIDE FRAMES ON TOGGLE PRESS

FIG. 2. FRONT VIEW OF BLISS TOGGLE PRESS

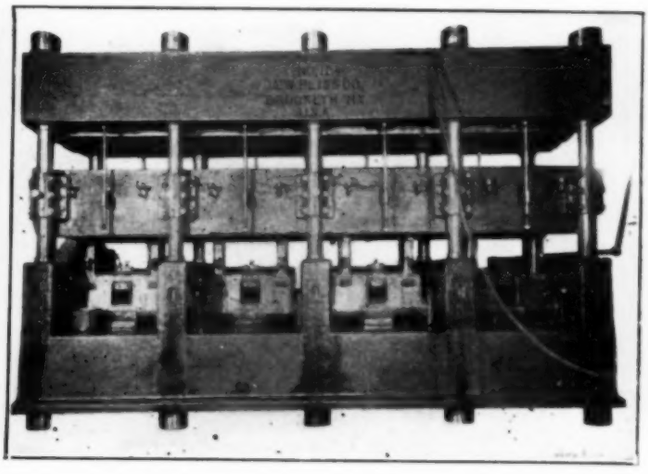


FIG. 3. REAR VIEW OF PRESS SHOWING GEARING

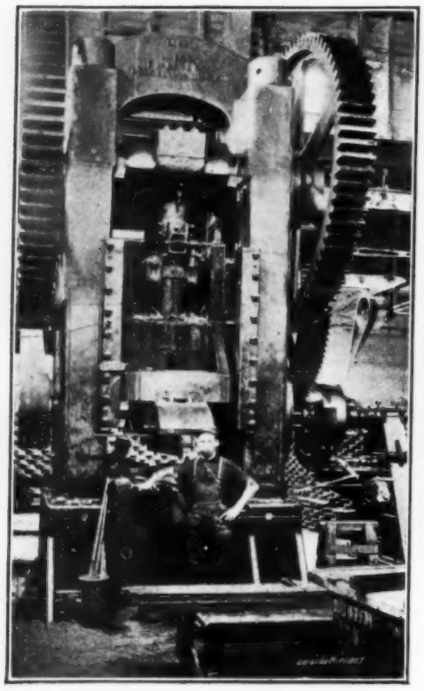


FIG. 4. 5000-TON PRESS FOR BENDING CROSS FRAMES

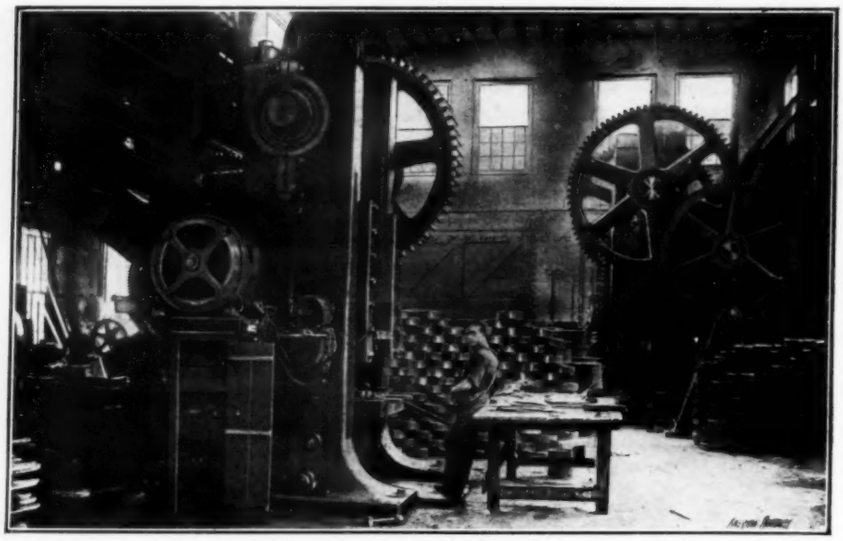


FIG. 5. 3000-TON PRESS FOR BLANKING AND BENDING CROSS FRAMES. (FRONT VIEW OF PRESS ON THE RIGHT SHOWN IN FIG. 4)

of eight strokes per minute. This press is used to blank and bend the cross members, the piece lying on the table at the right of the cut being the work on which it is at present engaged. The blanked pieces are seen on a bench directly in front of the press.

The press shown in the foreground of Fig. 5 weighs 120,000 pounds, and has a capacity of 3000 tons at the rate of

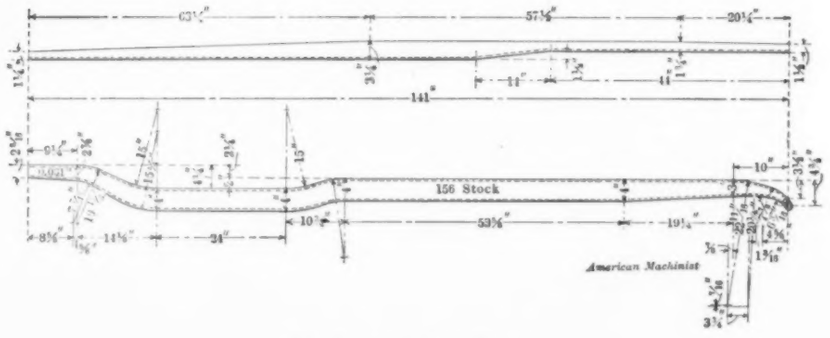


FIG. 7. THE SIDE FRAME

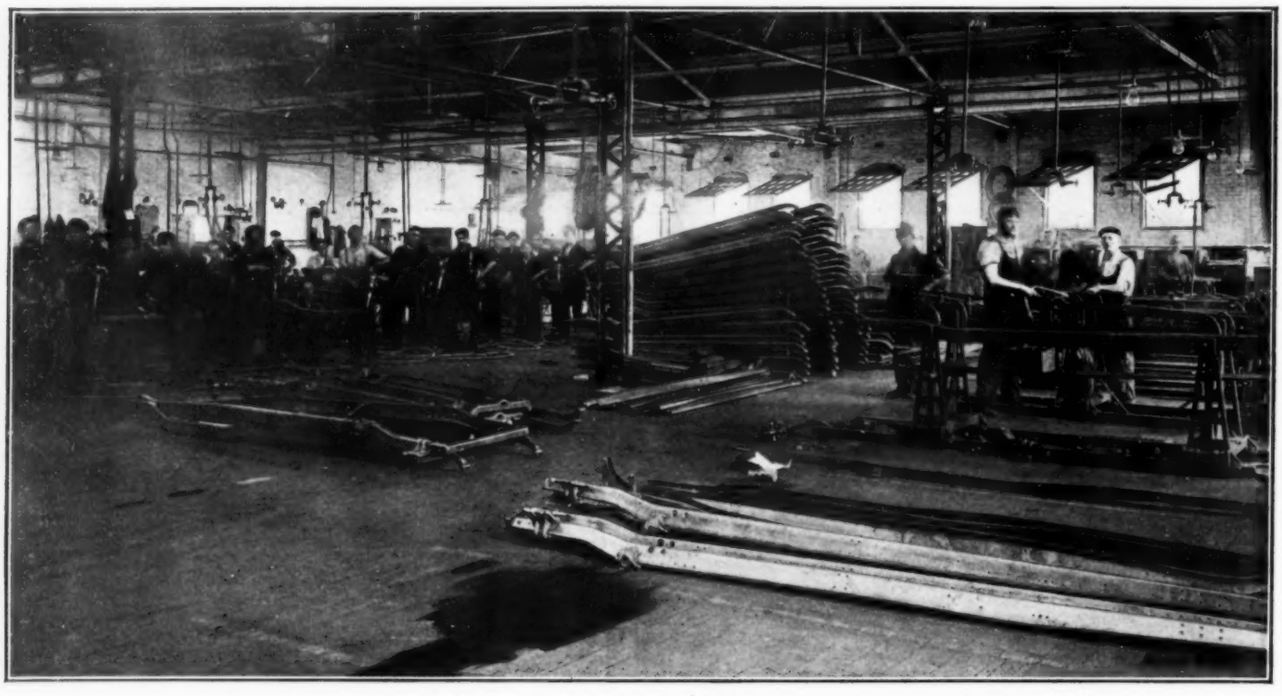


FIG. 6. ASSEMBLING THE AUTOMOBILE FRAMES

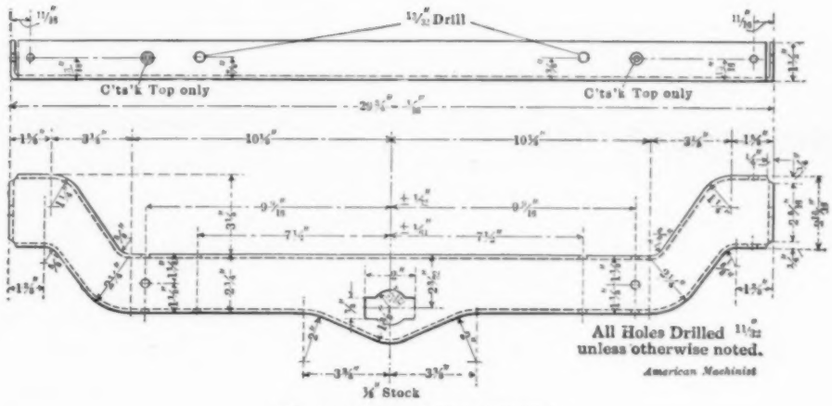


FIG. 8. FRONT DROP MEMBER

eight strokes per minute. This press is used on lighter cross members.

Fig. 6 shows the assembling department. A fixture is made for each different type of frame made. This fixture holds the side frames, cross members and all castings used in their proper positions while the riveting is accomplished, thus making them absolutely interchangeable. The riveting is done hot and pneumatic hammers are used.

The side frame, shown by Fig. 7, is one of several types made. Fig. 8 is an example of the cross member, that shown being known as the drop frame member. This piece is produced on the presses shown in Figs. 4 and 5.

The Modern Profession of Inventing

By Joseph B. Baker

The passing of the old time solitary inventor and the appearance of organized professional and team work. Sums spent by corporations in promoting invention.

The world used to class inventors with poets. Both were visionaries, but the inventor came and went in the common walks of life, a marked man who was for the most part laughed at, but who was occasionally revered as a genius when his dreams came true. It was in our earlier history, when steam became such a force in the material development of this country, that the inventor, as a type, appeared among us. The greater ones of that time—Howe, Corliss, Goodyear, Morse, Westinghouse, to mention only a few—will for long be recorded as *individuals* who conceived great ideas and brought them forth as epoch-making inventions. We still think of the sewing machine, automatic releasing steam-engine valve gear, rubber-vulcanizing process, electric telegraph and air brake each as the work of an individual inventor, working all alone—such is the human tendency to associate a single name with any advance in the world's thought.

But the romantic, individual genius, who worked out his invention by his unaided brain and then sold it to a powerful corporation for a fabulous sum, is now merged into or in many instances replaced by the professional inventor. For one Edison or Tesla of the present day—each a worthy peer of the giants of the early and middle nineteenth century—there are scores of *groups* of industrious, well trained men, distributed among the great manufacturing corporations and engaged in team work.

INFLUENCE OF MODERN ORGANIZATION

Modern organization makes available, and competition in manufacturing requires, the work of many inventors. The old-time inventor "got out a patent" as an adequate protection of his new idea just materialized. The child of his brain was ready for the market as it left his hand, a "new invention" manufactured in his own shop or taken up by a company that could make and sell it on a larger scale, and finding place without competition. The inventor's single patent, or small group of patents, with its announcements and disclosures in model drawings and wordings, and its list of claims, was the declaration of the entrance of a newly created enterprise into the commercial field. The patent was a certificate and an advertisement of the enterprise, and under its ægis his company might go ahead and build up a property.

With the spread of manufacturing, the protection afforded by patents has undergone a change. The minute details set forth in the string of patents that is now considered necessary publishes the invention—which is oftener than not a mere improvement in some existing art, process, machine or device—to a host of actual and possible competitors. Solving a problem one way does not necessarily interdict numerous other ways of solving it. Patents are sought by a company already formed to exploit the field, or by a new company entering the field. To secure adequate protection under these circumstances the patents of the several competing systems of nearly equal merit must be brought under one control, or else the idea must be thoroughly elaborated in the shop and drafting room and hedged about in the patent office; and here the solitary inventor is out of it, and organized work by a corps comes in.

THE MODERN METHOD

The modern profession of inventing has still another aspect. It is one thing to conceive the idea of a new device, another thing to conceive a new idea by which money may be made under modern industrial conditions and then put that idea into a marketable shape in wood and metal. One man may conceive the practical idea, it is true, making the first form of the device at his own bench and delivering it in working order. But in the face of the competition sure to follow success this work is only the beginning. Here invention as such pauses in the race, and passes the torch to manufacturing. The first inventor's model must be taken in hand by other men, and simplified, improved, cheapened—in a word, transformed into a manufacturing proposition. The invention, bolstered up by a chain of patents on improvements or on auxiliary machines and devices relating to its economical manufacture, and ready to put on the market, may bear the name of one of the men who did the earliest work—most likely of the one who conceived the germ idea, or of the one who had the most persistence or faith—but its development, constituting, perhaps, nine-tenths of the work necessary to insure profitable return from the idea, has been the work of a dozen or a score of other men whose names the general public never learns to honor.

This work may or may not be patented. The issue of letters patent may, in the judgment of some concerns, give advantage to competitors outweighing the theoretical protection afforded, and these concerns may prefer to have a hundred

or a thousand workmen see their machines daily to having their secrets disclosed in the records of the patent office. But none the less will the group of inventors be needed, and their work will not be the less valuable for never getting beyond the factory gates.

The old individual inventor sallied forth like a knight on solitary quest; the present-day manufacturing company is a community that sits still and by the work of its inventing force builds a wall of defense within which it may grow, develop its resources and plan its selling campaigns.

The Influence of Electrical Development

It was, perhaps, the later development of electricity that marked the change from the gifted but self-centered and often impractical individual dreamer to the professional inventor of today. The modern idea of inventing, as in everything else, is coöperation and coördination, and a group of men, not necessarily possessing extraordinary talents but working together, can strike out ideas among them, and will accomplish much more than the same number of men working separately. The secret is in the organization. There may not be direct coöperation, but team spirit is there. Each man is engaged in the research for which he has been fitted, by natural bent and in his school and subsequent training. In the chemical and research laboratory or designing room of which he is a member he has tools and materials and men to work with that he could not command of his own resources, and he has the stimulus of seeing his ideas take shape rapidly. Instead of hiding a scheme in his breast and passing years in periods of arduous work, alternating with generally longer periods of depression, a mere dreamy rumination, he makes a daily or weekly report and keeps regular shop or laboratory hours. He receives a regular salary, the continuance of which is not dependent on whether he makes a valuable invention every so often—though the amount may be. His advice in consultation is of value, thought the results are not always spectacular. On the other hand, when he does get up a new device or process he does not necessarily receive a royalty on it, or even a bonus or an increase of salary for it; the increased reputation that follows may be compensation enough. Selfishness and personality are not catered to, but honor certainly awaits successful effort, and his mind is relieved of the pecuniary anxiety which was the traditional menace of the old-time inventor.

The Case of the Telephone

The development of the American telephone system is a history of a few great primary inventions elaborated by team work, and of engineering problems solved as they arose by the same means. Given the telephone instrument itself, the task of the inventions departments of the parent Bell company and its operating companies, and later of the independent telephone companies, has been to adapt fundamental principles to the urgent needs of a rapidly growing local and long-distance telephone service. In many instances both the groundwork and superstructure of a new division of the art were built by the coöperating staffs of the affiliated companies. Among the results thus achieved were the perfecting of a commercially reliable transmitter; the study of the properties of telephone lines, leading to the revolutionizing of the old telegraph-line construction methods and to the construction of efficient telephone cables; the general evolution of switchboard and substation apparatus, culminating in the present common-battery system. Every new instrument, device or system had to be well considered, for it was to be an integral part of an electric communication system of stupendous magnitude; and mathematical research, laboratory work and practical trial have gone hand in hand with manufacturing.

The Growing Importance of Detail Improvements

Again, the demand for products of manufacture, that has made manufacturing as a career so attractive, has by the same token vastly increased the importance of detail improvements. The old inventor's mind worked on the obtaining of a novel result, *per se*, but the attention of the modern manufacturing company is ordinarily directed to the marketing of an enormous volume of the product; therefore refinements or simplifications often overshadow, in a money sense, the total returns from the great primary inventions of former times. A simplification of a manufactured article, by which nonessential operations in making it are cut out, or time and labor saved, often makes a difference of tens of thousands of dollars in the cost of its manufacture. And such simplifications are as often as not made by the operators of the machines, of their own initiative or under the pressure of the necessity of reducing costs to meet competition.

The Gayley Dry Blast

A shining example is the invention of James Gayley, the dry-blast process for blast-furnace operation, introduced about six years ago. This epoch-making work was accomplished by an intimate, day-by-day study of the deleterious effects of the variation in atmospheric conditions on iron smelting, and led to great saving in raw materials and improvement in precision of blast-furnace operation and uniformity of output by removing the moisture from the air blown into the furnace. Another instance is the work of Brown, Hulett and others in devising a complete system of coal and ore handling on the Great Lakes, completely revolutionizing former methods. By enormous electric-motor driven machinery, operated to unload specially designed vessels, the bringing of raw materials from a great distance to Pennsylvania and Ohio furnaces was made a commercial success, at a time when the depletion of the original local beds had threatened the very existence of the iron-smelting industry in the Keystone and Buckeye States.

Some Facts and Figures

What are some actual facts and figures of the working of this modern idea of an inventing staff in and of the manufacturing organization, and subordinate thereto, supplementing or replacing the individual inventor? What is the practice of large electrical, machinery, textile, public-service concerns, what is the usual plan of contract, what are the aggregate salaries paid to the members of the inventions department? The kind of companies that systematically go in for this plan of maintaining their industrial defenses may be indicated by a few well known names: National Cash Register Company, the Niles-Bement-Pond Company, the Hoe Printing Press Company, the Western Electric Company, the United Shoe Machinery Company.

Some companies, more particularly those having a tradition of secrecy, the result of prolonged patent litigation, are silent when approached with inquiries; others claim that although they apply for a large number of patents each year, on inventions made by their employees, and that such employees' salaries depend largely upon the inventive ability shown, they do not have any men employed solely for the purpose of making inventions. However, some data obtained a few years ago relating to the inventions department of a well known electrical manufacturing concern, may be taken as an illustration. About 800 men—not forming a separate group, but consisting of department heads, engineers, shop foremen all over the factory, and including the staffs of the regularly maintained chemical, physical and research laboratories—made up the force that evolves new patentable ideas. All of these men, "in consideration of one dollar and employment by the company," agree to assign to the company all inventions that they make, and the company supplies the tools, appliances and materials, and pays all the bills for drafting, experimental work and model making, and, of course, for getting out the necessary patents. This development work involves an aggregate expenditure of $2,500,000 a year in fostering and in patenting the work of these men, most of whom are comparatively unknown but who make inventions of the

greatest practical value in grappling with everyday manufacturing problems.

Their work is not made known (patented) for years, in many instances—either because the work is the part of a still incomplete whole, or in order to delay disclosure for reasons of manufacturing or selling policy. In a single year, approximately 1400 ideas had been disclosed to the company as patentable inventions by 300 men, and out of this number about 600 were considered novel and practicable enough to warrant application for letters patent. A corps of 12 lawyers and 28 assistants was maintained at the factory, besides two in Washington and one in Europe. The salaries paid to the members of the inventions department range from $2000 up to $10,000 or $12,000 a year, and only in rare instances does a man receive a royalty in addition to his salary.

Manufacturing Considerations Govern

In the actual work of making inventions, also, by this society of brain workers, manufacturing methods prevail. The presentation of a live problem may be followed by a solution in a few weeks or months, by concentration of several workers on various phases. On each invention, the work, beginning with one or two sketches by the man to whom the problem was originally assigned, will ordinarily include the following routine steps: A conference with the technical director of the company, an estimate of the cost of manufacturing, a conference with the sales department, an appropriation to cover cost of drawings and models, the making of drawings and their duscussion, including changes, a practical test of the first models and of improved models, an appropriation for manufacturing a small lot of the machine or device for general sale, the drawing up and filing of one or more patent applications, and finally, the design and building of the machines necessary to manufacture the invention economically.

The laboratories of this company cost about $75,000 a year to maintain, and are an extraordinary example of far-sighted investment in work which is largely pure science, forming a groundwork only for the solution of practical problems. The existence of such laboratories is, of course, an indication of the engineering standing of the company.

Another instance is the National Electric Lamp Association, composed of 23 manufacturing companies. The principal activity of this association is in an engineering department, which spends $350,000 a year and employs 150 men in research, technical and commercial engineering work. The physical laboratory alone is estimated to cost $25,000 a year to maintain, and its conduct as a commercial organization is unique in that it gives out the results of its work to appropriate scientific societies.

Although one may regret, for reasons of sentiment, the passing of the old-time inventor, the prosecution of inventive work as a branch of engineering presents larger opportunities to a larger number of workers. In my opinion, the newer state of things is more in accord with the spirit of democracy, "from every man according to his ability, to every man according to his need." May it not be said that in this age genius is largely replaced by organization?

Increasing Shop Capacities

Metal Working

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

Maas Brothers will equip a machine shop at Ottawa, Canada.

The American Brake Company, St. Louis, Mo., is enlarging its plant.

Smith & Clark, Ord, Neb., are erecting a blacksmith shop and garage.

The Wilson Auto Company will locate a factory in Montreal, Canada.

The Pneumatic Gate Company, Chicago, Ill., will erect a new foundry.

The Maine Central Railroad, Portland, Me., will build a new machine shop.

Southern Regal Auto Company, Atlanta, Ga., will erect a $20,000 garage.

The Massachusetts State Hospital, Boston, Mass., will install a machine shop.

The Hamilton (Ont.) Bridge Company will build extensive additions to its plant.

The Kent Machine Company, Toledo, Ohio, will erect a $20,000 addition to its plant.

The Empire Plow Company, Cleveland, Ohio, will erect a new two-story factory.

The Milwaukee (Wis.) Structural Steel Company will build an addition to its plant.

The Alberta Iron Rolling Mills will equip a $1,000,000 plant at Medicine Hat, Alberta.

O. & W. Thum Company, Grand Rapids, Mich., will build a one-story machine shop.

The Michigan Crank Shaft Company, Detroit, Mich., will erect a new factory building.

Frank Heilig, of Verdi, Minn., will erect a blacksmith shop to be occupied by J. Peterson.

The Canada Cycle and Motor Company is equipping a seven-story garage in Winnipeg, Man.

The Canton-Hughes Pump Comanpy will move its plant from Canton, Ohio, to Wooster, Ohio.

The Lattimer Supply and Machine Company will erect a new plant at Hazleton, Penn.

The Pittsburg & Lake Erie Railroad is planning a new repair shop at Dickerson Run, Penn.

The Orenstein-Arthur Koppel Company will double the capacity of its plant at Koppel, Penn.

The Vanrot Metal Company, Lorain, Ohio, whose plant was recently burned, will rebuild.

The Seneca Chain Company, Kent, Ohio, has awarded contract for its new $150,000 plant.

The Toledo (Ohio) Metal Furniture Company will erect a two-story addition to its plant.

The Keystone Watch Case Company, of Philadelphia, Penn., will locate a factory in Toronto.

The plant of the Philips Tin and Sheet Plate Works, at Weirton, W. Va., is to be doubled.

The Grand Trunk Pacific will erect a large dry dock and shops at Prince Rupert to cost $1,500,000.

The Globe Machine and Stamping Company, Cleveland, Ohio, is having plans prepared for a new plant.

W. B. Schnatterly, Nevada, Mo., will build a two-story machine shop at Hunter and Cedar streets.

The Milwaukee (Wis.) Separator Company, now occupying leased quarters, is planning to erect a plant.

The Ames Plow Company, Worcester, Mass., is said to be considering the removal of its plant.

The Wilys Overland Automobile Company has secured premises for a large new factory in London, Ont.

Brown & Co., operating the Wayne Iron and Steel Works, Pittsburg, Penn., are making improvements.

A. McDougall, First street and Twenty-second avenue, East Duluth, Minn., will erect a $10,000 garage.

The Hamilton Wire Works is erecting a large branch factory at Lulu Island, New Westminster, B. C.

The General Electric Company has filed plans for a factory building at 350 Abbott road, Buffalo, N. Y.

The Superior Steel Company, Carnegie, Penn., is increasing the capacity of the hot-rolling department.

The Banting Machine Company, Toledo, Ohio, has made application for a permit to erect a new building.

The United States Sanitary Manufacturing Company, Monaca, Penn., is erecting an extension to its foundry.

The Grand Trunk Pacific has purchased land at Regina, Sask., on which new shops will be built at once.

The Canadian General Electric Company, Peterboro, Ont., is making large extensions to its machine shops.

The Moline Automobile Company, East Moline, Ill., has awarded contract for an addition to its factory.

Plant of the Union Dry Dock Company, at Weehawken, N. J., was damaged by fire to the extent of $150,000.

The George Koenig Company will erect a factory for the manufacture of a hoist and ladder at Le Seur, Minn.

The George Whiting Company, Chicago, Ill., manufacturing punches and shears, will erect a new machine shop.

The Pennsylvania Railroad is taking bids for the erection of new shops and roundhouse to be located at Orangeville, Md.

The plant of the Ohio Foundry and Manufacturing Company, at Steubenville, Ohio, was destroyed by fire. Loss, $25,000.

The Kanawha Chemical Fire Engine Company, South Charlestown, W. Va., will soon be in the market for Fox lathes.

The Pierce-Racine Automobile Company, of Racine, Wis., will establish a repair shop, distributing plant, etc., at Little Rock, Ark.

The Tuttle Motor Company, Canastota, N. Y., is building a new machine shop. Is now making purchases of machine tools.

The Chicago (Ill.) Bridge and Iron Company, manufacturing tanks, silos, etc., is building a branch plant at Greenville, Penn.

The Brandt Manufacturing Company, Hastings, Minn., making agricultural sprayers, is looking for a site on which to erect a new plant.

The West End Motor Company, Duluth, Minn., is remodeling its factory at Michigan street and Twenty-first avenue West for a garage.

The National-Acme Manufacturing Company, of Cleveland, Ohio, building screw machines, is to establish a plant in Montreal, Canada.

The United States Steel Corporation has completed plans for the construction of a $5,000,000 steel plant at Ballard station, Seattle, Wash.

The Saco & Pettee Machine Shops, Newton Lower Falls, Mass., is making an addition to its machine shop and will erect a new building for automatics.

The Pilot Motor Company, Richmond, Ind., is considering the removal of its factory and is making investigation with a view of securing suitable site.

Plans are being drawn by the New York, New Haven & Hartford Railroad for a new engine house to be erected at Providence, R. I., to cost $290,000.

The Lackawanna Steel Company has authorized the expenditure of about $800,000 for the construction of an additional merchant mill at Buffalo, N. Y.

It is announced that work will be started at once on the big new roundhouse for the New Haven Railroad, on the Quinnipiac Meadows, New Haven, Conn.

The Pennsylvania Railroad has let contract for the erection of a large machine shop, power house, etc., at Northumberland, Penn., to cost about $225,000.

The Pittsburg (Penn.) Motor Car Company is looking for a suitable location on which to erect a plant that would give employment to 200 or more men.

The plant of the Davenport (Ia.) Locomotive Works was burned, causing a damage of $20,000; $12,000 of this loss was on machinery. New building will be erected.

The Pittsburg (Penn.) Bolt and Screw Company will move to Gary, Ind., where a large new plant will be erected. The concern will be known as the Gary Bolt and Screw Company.

The Wright Cooler and Hood Company, now at 1545 Michigan avenue, Chicago, Ill., will move to Muskegon, Mich., where a new plant will be erected. The company manufactures coolers and hoods for automobiles.

The Huron River Manufacturing Company, Ann Arbor, Mich., organized to establish a plant for the production of automobiles and their parts, is now taking bids on the first of new factory buildings to be erected.

The Potter & Johnston Machine Company, Pawtucket, R. I., building machine tools, will add a line of cotton machinery to its product. The company is now building an addition to its works giving a lot of additional floor space.

Charles H. Hart, of Denver, Colo., and associates, are planning for the construction of a $500,000 factory in San Antonio, Tex., for the manufacture of wire goods, tinware, washing machines and also a foundry and structural sheet works.

The Collins Gear and Motor Works will locate a plant at Canonsburg, Penn. This is a new company, composed of Pittsburg capitalists, which will manufacture a new appliance for automobiles invented by D. P. Collins, of Pittsburg. Plant will be erected on Alexander place.

Charles E. Levy, of the firm of L. Levy & Sons, of New Orleans, La., and a member of the New York and New Orleans cotton exchanges, Cotton Exchange building, New York City, is investigating throughout the Middle Atlantic section for the location of an automobile plant that will give employment to 300 to 1000 men. Mr. Levy reports that it is intended to manufacture a new car called the "Simplicia," and all kinds of motor vehicles. The cost of this factory building is estimated at $1,000,000.

General Manufacturing

The Atlanta (Ga.) Paper Company is erecting a new plant.

A new electrical substation will be equipped at Ingersoll, Ont.

Robert McGinnis, of O'Neil, Neb., will erect a modern creamery.

John Treber, of Deadwood, S. D., will erect an ice-making plant.

Canajoharie, N. Y., will install new waterworks to cost $150,000.

Ottawa, Canada, will spend $2,000,000 extending its water system.

The Nearsteel Company, Jersey City, N. J., will install a new cupola.

The McLaughlin Paint Company, Ottawa, Ont., will double its plant.

Pickup & Kean, dyers, Allentown, Penn., are erecting a large addition.

The Allentown (Penn.) Silk Dyeing Company is erecting an addition.

The ice plant of the Walla Walla (Wash.) Brewing Company was burned.

Oscar Betteridge, Shenandoah, Penn., is building a new knitting mill.

Churchill & Allen, Lynn, Mass., are in the market for veneer machinery.

H. B. Smith Heater Company is in the market for feed-water pumps.

The Houlton (Me.) Woolen Mill will erect a new four-story mill building.

The city of Winnipeg, Man., is in the market for well-drilling machinery.

The Walpole (Mass.) Rubber Company is building additions to its plant.

Messrs. Kapes and Kinng will locate a large flour mill at Vonda, Sask.

The Belmar (N. J.) Waterworks is to increase the capacity of its plant.

The Kilgour Couch Company is equipping a new factory at Stratford, Ont.

The Twin City Granite Works, Minneapolis, Minn., will build an addition.

The Muscatine (Iowa) Produce and Pure Ice Company is erecting a plant.

The Wentachee (Wash.) Milling Company will erect a three-story flour mill.

The Owen Sound (Ont.) Furniture Company will build a large new factory.

The plant of the Florence (Ala.) Column Company was burned. Loss, $20,000.

Fire destroyed the plant of the Stevens Tank and Tower Company, Auburn, Me.

Stengel & Rothchild, leather manufacturers, Newark, N. J., are building an addition.

H. F. Sommers & Co., Newark, N. J., leather manufacturers, are building an addition.

J. E. Dayton, Williamsport, Penn., is building a large addition to his shoe factory.

The Michelin Tire Company, Milltown, N. J., is erecting an addition to its plant.

The Fiske Rubber Company, Chicopee, Mass., will require boilers for its new mill.

The American Textile Company, Pawtucket, R. I., making laces, will erect an addition.

The Menasha (Wis.) Woodenware Company is contemplating the removal of its plant.

The American Glass Specialty Company, Monaca, Penn., is erecting a large addition.

Swift & Co., of Chicago, has started work on a new fertilizer plant in Cleveland, Ohio.

The Canadian Smelting and Refining Company will locate a large plant at Orillia, Ont.

The Holeproof Hosiery Company, Milwaukee, Wis., will build an $18,000 addition.

The plant of the Saint Clair Tile Company, at Eaton, Ohio, was burned. Loss, $12,000.

The Agricultural Chemical Works, Los Angeles, Cal., will erect a one-story addition.

Campbell & Stearns will spend $25,000 for new machinery for a sawmill at Gracefield, Que.

Long & Koch Company, jewelry manufacturers, are building a new plant in Newark, N. J.

Edmonton, Alberta, is in the market for a complete equipment for a hydroelectric plant.

The Specialty Manufacturing Company, Stonington, Conn., will install a steam-power plant.

The city council, Columbus Junction, Iowa, is preparing to establish an electric-light plant.

The citizens of Hartselle, Ala., voted to issue bonds for waterworks and electric-light plants.

The Greendale Lumber Company, Worcester, Mass., is in the market for a steam boiler.

The plant of the Winnebago (Minn.) Milling Company was destroyed by fire. Loss, $50,000.

The Weber Baking Company, Waverly avenue, Newark, N. J., will erect a three-story addition.

The sawmill of E. J. McNeeley & Co., Tacoma, Wash., was destroyed by fire. Loss, $550,000.

Welland, Ont., will spend $15,000 for new pumps, water wheels and other waterworks equipment.

The Pittsfield (N. H.) Electric Light and Power Company will install a steam engines and boiler.

The Mengel Box Company, of Louisville, Ky., will erect a large box factory in Jersey City, N. J.

A transformer station and complete hydro-electric power plant will be equipped at Port Credit, Ont.

The New York Central Railroad will build another switch tower at Chatham, N. Y., to cost $30,000.

The Monmouth Memorial Hospital, Long Branch, N. J., is building a new power plant and laundry.

The Leggitts Creek Colliery, Scranton, Penn., is erecting a new 1800-horsepower boiler house.

The American Musical Supply Company, Jersey City, N. J., will build a new three-story factory.

The Citizens Light, Heat and Power Company, Mobile, Ala., will spend $700,000 on improvements.

The Penobscot Chemical Fiber Company, Great Works, Me., will build a large water-power plant.

The Chemical Laboratories, Ltd., of Toronto, Ont., will build a $1,000,000 plant at Welland, Ont.

The fat rendering plant of Robert Stern, at Secaucus, N. J., was destroyed by fire. Loss, $60,000.

Grain elevator of the Rutland Transit Company, at Ogdensburg, N. Y., was burned. Loss, $200,000.

The plant of the Wm. Musser Lumber Company, Spokane, Wash., was destroyed by fire. Loss, $200,000.

The Connelly Springs (N. C.) Mills will rebuild its woodworking plant and corn mill, recently burned.

City of Carmen, Okla., will vote on issuance of $15,000 bonds for waterworks and electric-light extensions.

The Lawrence Webster Company is to erect a large plant in Malone, N. Y., for the manufacture of cloth.

The Cooper Paper Box Company, Buffalo, N. Y., is having plans prepared for a new three-story factory.

The John F. Bogle Comanpy, Jersey City, N. J., manufacturing strawboard, will erect a two-story addition.

An electric-light and power franchise has been granted to the Ashland Power Company, at Bessemer, Mich.

The Springfield (Mass.) Street Railway is considering the installation of one or two more steam boilers.

The Triangle Mining and Developing Company, of Clinton, Mont., will erect a $50,000 concentrating plant.

The schoolhouse department of the city of Beverly, Mass., is asking for bids on a horizontal-tubular boiler.

The Revere Rubber Company will build a plant in Providence, R. I., for the manufacture of rubber tires.

Fire destroyed the leather factory of Samuel E. Knapp, at Danvers, Mass., causing a loss of over $30,000.

The Chas. Wolf Packing Company, Topeka, Kan., will install another ammonia compressor and generating set.

The Lorraine Manufacturing Company, Pawtucket, R. I., will install a new spinning and weaving machinery.

Medicine Hat, Alberta, wants two direct connected gas-engine driven, 1250-kilowatt, alternating-current units.

The Geo. A. Learned Shoe Company, Newburyport, Mass., is looking for a suitable site on which to erect a plant.

The Winchester Repeating Arms Company, New Haven, Conn., is in the market for steam pumping machinery.

The mill of the Santiago Milling, Mining and Tunnel Comanpy, at Georgetown, Colo., was burned. Loss, $20,000.

The Newton (Kan.) Electric Light Company will install an additional direct connected engine and generator.

The Flavelle Silverwood Company will build a large plant at London, Ont., for cold-storage and packing purposes.

C. B. Pride, of Spokane, Wash., is arranging for the erection of a paper mill to cost $1,000,000, at Seattle, Wash.

The Cumberland (Md.) Mattress factory at William and Orchard streets, was destroyed by fire. Loss, $10,000.

Fire damaged the plant of the Akron Roofing and Tile Company, at South Akron, Ohio, to the extent of about $40,000.

The Macbeth-Evans Company, of Pittsburg, Penn., will build an addition to its glass plant at Charlerol, Penn.

The Western Fuel Company, Nanaimo, B. C., will equip a private water-supply system and is in the market for pumps, etc.

The Norton Company, of Worcester, Mass., will build a factory in Toronto, Ont., for the manufacture of emery wheels.

The Standard Sanitary Manufacturing Company, Pittsburg, Penn., is building an addition to its plant at New Brighton.

Fairview, Okla., will expend $50,000 for extension of its waterworks, electric-light system, etc. J .M. Voorhees, city clerk.

The sawmill and box factory of James Walker & Co., at Basin Mills, Orono, Me., was destroyed by fire. Loss, $100,000.

The city of Lowell, Mass., is asking for bids on a crank and flywheel, high-duty pumping engine of 8,000,000 gallons capacity.

Eisenhuth & Sons, shoe manufacturers, Sellinsgrove, Penn., will move to Williamsport, Penn., and construct a new plant.

Dauphin, Man., is in the market for a large quantity of gate valves for fire hydrants and special castings for waterworks purposes.

The Farmers Co-Operative Brick and Tile Company will soon commence the erection of a plant to cost $200,000, at Mason City, Iowa.

A $100,000 factory and warehouse will be erected for the Regal Buggy Company, at Eleventh and Howard streets, St. Louis, Mo.

Fire destroyed the plant of the Central Box Board Company, at Sterling, Ill., owned by Armour & Co., of Chicago. Loss, $150,000.

The Standard Company, Torrington, Conn., manufacturing spokes, etc., has awarded contract for the erection of an additional factory.

A two-story factory building will be erected at Kansas City, Mo., to be occupied by the Kansas City Vehicle and Automobile Company.

The Canadian Power and Paper Company, with headquarters in Toronto, will spend $10,000,000, establishing mills and power plants.

City of La Plata, Mo., is having plans prepared by Burns & McDonald, Scarritt building, Kansas City, Mo., for waterworks and sewer system.

The shaft house, with all its machinery, at the Pride of Cripple Creek Mine, on Ironclad Hill, Cripple Creek, Colo., was destroyed by fire.

The Oneida Community, Ltd. (hardware department), Sherrill, N. Y., will increase the power capacity of its machine shop from 250 to 1000 horsepower.

The planing mil and box factory of the Myzelle & Imhoff Company, at Second and F streets, San Bernardino, Cal., recently burned, will be rebuilt immediately.

Fire destroyed the West Brea Ridge Colliery, owned and operated by the Philadelphia & Reading Coal and Iron Company, at Mahoney Plane, near Mahoney City, Penn.

The Richmond (Va.) Power Corporation, recently organized, will equip a plant at Midlothian for the generation of light and power. S. D. Crensha, of Richmond, is vice-president.

The Hazen (Ark.) Power and Light Company, organized with $25,000 capital, will commence the construction of its plant to furnish electric power. Will also manufacture ice.

The Waterworks Improvement Board, of Conway, Ark., feted with the city council, plans for the proposed system and an estimate showing approximate cost would be about $95,000.

The High Ground Dairy Company, of 451 Madison street, Brooklyn, N. Y., has commenced the erection of a large creamery at Norwich, N. Y., to be equipped with the latest machinery.

The Great Northern Implement Company, Minneapolis, Minn., has had plans drawn for a seven-story warehouse at Seventh avenue and Third street, to replace the one burned a short time ago.

The United States Bobbin and Shuttle Company, Manchester, N. H., has had plans prepared for three new buildings to cost over $40,000. These will comprise a bobbin mill, dry house and new boiler house.

The Willetts Company, of Pittsburg, Penn., has commenced the erection of a plant in Fairmont, W. Va., for the manufacture of glass pots, tank blocks and other clay products used in the manufacture of glass.

The board of chosen freeholders, of Hudson county, N. J., will receive bids for three horizontal-tubular boilers for a new boiler room at the Almshouse, also for the installation of a new bakery and laundry at the penitentiary.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids September 20 for two feed-water heaters and purifiers (schedule 2865); September 27—Pipe fittings, hose, composition unions (schedule 2856), wattmeters (schedule 2854).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids September 13, for 12 pneumatic scaling hammers, 27 pneumatic drilling machines (schedule 2845), one 15-horsepower induction motor, 60 spiral steel springs (schedule 2859), plate-bending and flanging rolls (schedule 2844).

M. J. Tappins, secretary State board of control, Madison, Wis., will receive bids until 2 p.m., September 12, 1910, for one deep-well turbine pump for 17-inch well. Each bid must be accompanied by certified check for $200. Specifications on file at office of M. J. Tappins, secretary, and 31 Vroman building, Madison, Wis.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids September 13 for 4150 pounds brass sheet (schedule 2851), 1850 pounds brass sheet (schedule 2862), 6000 pounds round phosphor bronze, 40,200 pounds forged steel (schedule 2859), 50,000 pounds mild steel, 19,600 pounds medium bar steel, 56,000 pounds ingot tin, 12,000 pounds sheet zinc, 10,350 pounds cold-rolled steel (schedule 2847).

New Incorporations

Everett Motor Car Company, Dayton, Ohio. Capital, $50,000. Wm. A. Schroyer, S. A. Seward, etc.

Lisbon Auto Truck Company, Lisbon, Ohio. Capital, $50,000. Incorporators, A. H. Wyatt, W. H. Kitts.

Garage Service of America, New York. Garage. Capital, $25,000. Incorporators, R. H. Wagoner, R. C. Davey, etc.

The Gatesville Light and Power Company, Gatesville, Tex. Capital, $15,000. Incorporators, J. R. Raby, J. A. Gilchrist, C. F. Caruth.

Pure Ice Company, Bowling Green, Ohio. Manufacture ice. Capital, $10,000. Incorporators, B. F. Bliss, J. W. Bliss, Geo. E. Bliss, etc.

Westbrook Garage and Machine Company, Westbrook, Me. Buy, sell, manufacture and repair automobiles, etc. Capital, $10,000. John T. Skillins, president.

American Shop Equipment Company, Portland, Me. Manufacture and sell all kinds of railroad and shop supplies. Capital, $300,000. Clarence E. Eaton, president.

Capin Auto Supply Company, Chicago, Ill. Manufacture and deal in automobiles. Capital, $50,000. Incorporators, Daniel C. Beard, Glenn E. Plumb, Morgan L. Davis.

Cummings Auto Sales Company, Columbus, Ohio. General automobile repair business. Capital, $10,000. Incorporators, Chas. E. Cummings, Frank S. Cummings, etc.

Cecil E. Gibson Motor Car Company, Indianapolis, Ind. Manufacturers and dealers. Capital, $25,000. Incorporators, Cecil E. Gibson, W. R. Wheeler, Ira M. Holmes.

Dundee Silk Throwing Company, Passaic, N. J. Manufacture silk and other textile fabrics. Capital, $25,000. Incorporators, S. Birnbaum, Robert Speirs, B. O'Keefe.

Northwestern Electric Equipment Company, Jersey City, N. J. Manufacture electrical apparatus. Capital, $600,000. Incorporators, H. H. Flagg, A. B. Trigge, J. R. Turner.

Garage Service Company of America, New York. Maintain garage, etc. Capital, $25,000. Incorporators, R. H. Waggoner, R. C. Davey, 37 Liberty street, New York, etc.

Olmstead-Flint Company, New York. Manufacture belting and power transmission. Capital, $45,000. Incorporators, E. J. Forhan, G. F. Martin, H. P. Jones, 154 Nassau street.

J. H. Valentine & Co., Syracuse, N. Y. Manufacture and deal in motors, engines, machinery. Capital, $20,000. Incorporators, John H. Valentine, Jas. F. Sanchez, Chas. G. Hanna.

Eclipse Railway Supply Company, Cleveland, Ohio. Manufacture street-car fenders, etc. Capital, $60,000. Incorporators, J. Fasler, Jr., L. S. Lommasson, A. Weiss, etc.

Cote Automobile Company, Tupper Lake, N. Y. Manufacture auto sleighs, cars, etc. Capital, $15,000. Incorporators, Michael Kennedy, Chas. H. Marsha, Theodore Cote, etc.

Stoner Manufacturing Company, Dayton, Ohio. Manufacture kitchen furniture and utensils. Capital, $25,000. Incorporators, Owen S. Stoner, W. J. Judy, F. W. Fisher, etc.

Taylor Brothers & Co., Fulton, N. Y. Manufacture and deal in paper machinery and supplies. Capital, $40,000. Incorporators, C. C. Benedict, J. A. Benedict, T. Allen Benedict.

American Automatic Boiler Feeder Company, Waterville, Me. Manufacture and sell automatic boiler feeders, boilers, engines, etc. Capital, $100,000. Geo. W. Boynton, president.

Chicago Regal Motor Company, Chicago, Ill. Manufacture and deal in automobiles. Capital, $10,000. Incorporators, Glenn E. Holmes, Donald H. McGilvray, Earle F. Tilley.

Malgan Brush Company, Newark, N. J. Manufacture brushes. Capital, $200,000. Incorporators, C. W. Fairlie, Newark; Joseph H. Bowne, East Orange; J. Addison Bowne, Orange.

Scioto Auto Car Company, Chillicothe, O. Manufacture automobiles, automobile parts, etc. Capital, $150,000. Incorporators, F. C. Arbenz, Richard Enderlein, Robert W. Whitney, etc.

MacDonald-Hilderscheid Company, Columbus, Ohio. Manufacture printing machinery, etc. Capital, $10,000. Incorporators, Wm. E. MacDonald, Wm. A. Hilderscheid, S. P. Cross, etc.

Newark Wrapping Machine Company, 763 Broad street, Newark, N. J. Manufacture machinery. Capital, $5,000,000. Incorporators, David D. Engle, N. J. Matthews, Harry D. Engle.

McCartney Boiler Company, Mobile, Ala. Manufacture and deal in boilers, engines and machinery. Capital, $50,000. Incorporators, Thos. P. Martin, Jas. E. Martin, James McCartney, etc.

The New Enterprise Company, Hamilton, Ohio. Capital, $10,000. Manufacture and sell washing compounds and soaps. Incorporators, Henry Hagerman, Charles E. Campbell, Jr., Harry Brick.

Craghan Foundry Company, Fremont, Ohio. Capital, $10,000. Manufacture and sell castings and metal parts of all kinds. Incorporators, William A. Baker, John E. Van Boxel, Frank Van Boxel.

American Auto Sales Company, Cleveland, Ohio. Capital, $50,000. Do a general automobile business and repair motor cars. Incorporators, George H. Canniff, John K. Corwin, E. P. Kinney.

McLeary Engineering Company, Toledo, Ohio. Manufacture motors for aëroplanes, do automobile repairing, etc. Capital, $25,000. Incorporators, Edward McLeary, O. P. Bernhart, S. J. Logan, etc.

O. J. Warman Aluminum Foundry and Machine Company, Madisonville, Ohio. Manufacturing and machining aluminum. Capital, $15,000. Incorporators, O. J. Warman, Roy Warman, R. E. Morrison, etc.

Kasper & Koetzle, Brooklyn, N. Y. Manufacture and deal in iron, steel, manganese, copper, etc. Capital, $30,000. Incorporators, Wm. Kasper, 60 Richmond street; Frederick Koetzle, 69 Ridgewood avenue, etc.

Seymour Auto Supply Company, New York. Manufacture devices and supplies for automobiles. Capital, $50,000. Incorporators, P. C. Brashear, West New Brighton, S. I.; S. Suits, H. J. Howland, Newark, N. J.

The Wallace-De Wilde Company, Newark, N. J. Manufacture automobiles. Capital, $10,000. Incorporators, Henry A. O'Brien, New York; John Beekman Wallace, Jersey City, N. J.; Herbert De Wilde, New York.

Moore Auto Skid Preventer Company, New York. Manufacture motors, engines, automobiles, appliances, etc. Capital, $500,000. Incorporators, Franklin J. Berry, East Orange, N. J.; Ernest Lewin, 1374 Boston road, New York, etc.

Pennsylvania Motor Car Company, New York. Manufacture automobiles, motors, engines, aëroplanes, etc. Capital, $50,000. Incorporators, D. Hamilton, 738 East One Hundred and Seventy-sixth street; A. A. Russell and L. H. Denny, 344 West Fifty-eights street, New York.

Forthcoming Meetings

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care, 505 Pearl street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

The "Gas Saver" brazing forge; circular. J. L. Lucas & Son, 2 Fox St., Bridgeport, Ct.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Will pay 75 cents for copy of AMERICAN MACHINIST, issue of March 26, 1908. J. O. Smith, 325 Waterman St., Providence, R. I.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 900 G St., Washington, D. C. Write for Inventor's Handbook.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Any broken machinery parts expertly welded by oxy-acetylene process; difficult repairs requiring skilful preheating are our specialty; automobile cylinders and crank cases also; ask for detailed information, references, etc.; we positively weld (not braze) cast iron, aluminum and other metals; no charge unless successful; one trial will convince you. Waterbury Welding Works, Waterbury, Conn.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Salesmen to handle on a generous commission basis, a well advertised and quick selling line of lathe tools; commissions given on all orders received from prescribed territory; send references with reply. Address "R. T.," AMERICAN MACHINIST.

Wanted—For England in mills making brass and copper tubes, plates and rods, a competent overseer; a clever millwright with uptodate knowledge of methods of manufacture and capable of applying same, is the person required; state age, qualifications, previous situations and salary required. Care "Roller," P. O. Box 459, Hartford, Conn.

DELAWARE

Wanted—A man who is thoroughly competent to take charge of profiling machines in

the manufacture of high-grade firearms; we have an excellent opportunity for a competent man to advance himself to his full capacity; steady employment and good wages will be paid successful applicant. Box 897, AM. MA.

ILLINOIS

Wanted—A first-class model maker and experimental man for adding machine of strictly high class; state experience and salary. Box "Z Y X," AMERICAN MACHINIST.

Wanted—By growing Chicago concern, first-class draftsman with experience in original designing and ability to work out ideas submitted; also a high-grade die and tool designer of experience, with a thorough practical knowledge of die making; must be a good draftsman; in each case give age and experience in full and wages desired in first letter. Box 892, AMERICAN MACHINIST.

INDIANA

Wanted—Foreman, a man capable of handling motor, rear axle, transmission and chassis assembly in factory where quality first then quantity counts; factory located at Indianapolis, Ind. Box 906, AMER. MACH.

MASSACHUSETTS

Wanted—Experienced and designing draftsmen. Address replies to Supervisor of Drafting Rooms, General Electric Co., Pittsfield, Mass.

Pattern storage man wanted at once; must understand drawings and be familiar with patterns; steady work and best of conditions in attractive new building. Deane Steam Pump Co., Holyoke, Mass.

Speed boss wanted for machine shop of 200 men; a first-class, energetic, exacting, up-todate man with thoroughly practical machine shop experience; write us fully so that your first letter will clearly state your experience and ability to do the required work; that is, state clearly and concisely your education and experience, stating age and compensation expected to start, and give any references you might wish us to write to. Box 912, AMERICAN MACHINIST.

MICHIGAN

Wanted—At once, draftsman with at least two years' experience on gasolene engine and engine jig work; none but first-class man need apply. Box 917, AMERICAN MACHINIST.

NEW JERSEY

Wanted—An experienced man for foreman on assembling small and intricate machine work; must be an expert mechanic, know how to handle men and show results; give age, experience, wages expected and references. Box 918, AMERICAN MACHINIST.

NEW YORK

Machinists Wanted—First class planer, bench and floor hands; new shop, new tools, good wages and steady position for the right men. Address or apply direct to the Autopress Co., College Point, N. Y.

Wanted—Four or five first-class all-around machinists and two good patternmakers; give full details of past experience, where now employed, reference and age; good wages and permanent employment to good men. Box 881, AMERICAN MACHINIST.

Draftsmen Wanted—A large and well known automobile company in New York State requires experienced mechanical draftsmen and detailers; give age, experience and salary expected and when could report for work. Box 898, AMERICAN MACHINIST.

OHIO

Wanted—General foreman for about 250 men in machine shop and tool room of a large engine manufacturing plant in Ohio; must be an experienced and aggressive man, able to get maximum capacity in high grade accurate work at the proper cost; state fully, experience number of men handled, age, present salary, etc. Box 916, AMER. MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Floor hands and fitters on machine tool work. Colburn Machine Tool Co., Franklin, Penn.

Wanted—Experienced foundry foreman for medium sized shop; one familiar with pump and engine work preferred; give full details of experience, salary expected, etc. Box 929, AMERICAN MACHINIST.

Blacksmith foreman for Philadelphia plant; fully experienced and competent to take entire charge of 200 men and thoroughly familiar with heavy forging machines, steam drops, bulldozers, etc. Box 905, AM. MACH.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

RHODE ISLAND

Wanted—Scrapers, experienced on medium machine tools; expert men only; highest pay, steady employment. Box 907, AMER. MACH.

TENNESSEE

Wanted—First-class machine tool repair man, regular toolmaker who can handle repairs preferred; give experience and reference; permanent position to right man. Address Southern Engine & Boiler Works, Jackson, Tenn.

WISCONSIN

Wanted—Draftsman, bright young man to take charge of a small drafting room. Address "A. Z.," AMERICAN MACHINIST.

Wanted—A thoroughly capable and experienced machine designer and draftsman; one who has had experience in the building of automatic machinery; give experience, references and salary desired in first letter; if not thoroughly competent do not apply. National Wrapping Machine Company, Enterprise Bldg., Milwaukee, Wis.

FOREIGN

Commonwealth Government, offices, 72 Victoria street, London, S. W., invite applications for the position of manager of a small arms factory at Lithgow, New South Wales, Australia; age not to exceed forty; testimonials, statement of service and qualifications for post required; previous experience of manufacture of small arms essential; candidates have to undergo medical examination; salary £750. Applications to be addressed, Secretary Defense Department, Melbourne, Australia, to arrive not later than October 31.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—Position as general superintendent; have had a large experience designing and building gas engines. Box 925, AM. MA.

Wanted—Position as assistant shop superintendent by mechanical engineer, well up in workshop practice, having had eight years' practical workshop experience and nine years in drafting room on general engineering, shop layouts, rolling mill machinery, machine tools, jigs and fixtures and special tools and machinery. Box 926, AMER. MACHINIST.

MASSACHUSETTS

Special machine designer wishes to change. Box 864, AMERICAN MACHINIST.

As superintendent or assistant, experienced all departments shop and foundry; large works. Box 919, AMERICAN MACHINIST.

Man with technical training, experience as chief draftsman, systematizing shop work, assistant superintendent, installation of premium system, wants position of assistant superintendent or installing premium system. Box 879, AMERICAN MACHINIST.

NEW JERSEY

Experienced mechanical draftsman wishes position. Box 908, AMERICAN MACHINIST.

Mechanical engineer of long experience in the manufacture and design of engines, meters, mathematical instruments and general iron and brass goods manufacturing, is open for engagement. Address A. B. Calkins, 155 Home Ave., Passaic, N. J.

NEW YORK

Mechanical engineer, 10 years' experience, open for engagement. Box 855, AMER. MACH.

Mechanical graduate wants to represent reliable concern; New York preferred. Box 931, AMERICAN MACHINIST.

Mechanical engineer, 30, of good training and practical experience, desires position; references. Box 922, AMERICAN MACHINIST.

General foreman, A-1 designer of dies, tools and special machinery; good inventor; can handle help to advantage. Box 914, AM. MA.

Wanted—By a young man, a position as general foreman of boiler shop; experience in some of the largest contract shops. Address "Boilermaker," Box 920, AMER. MACHINIST.

Mechanical superintendent of a large manufacturing plant, with twenty years' experience in general machine and foundry practice, desires making a change. Box 901, AMERICAN MACHINIST.

Foreman toolmaker, experience designing jigs and fixtures for interchangeable parts seven years; reference last employer to executive and mechanical ability. Box 927, AMERICAN MACHINIST.

Expert draftsman, now employed, wishes position where ability and conscientious endeavor will be appreciated; long experience in mechanical and commercial lines; best of references. Address Box 921, AMER. MACH.

High grade designer, with wide experience, both practical and technical, on tools and special machinery for manufacturing interchangeable parts; expert on dies, including subpress; will be open for engagement October 1; location immaterial. Box 915, AMER. MACH.

Designer, graduate engineer, age 33, over 12 years' experience adding machines, typewriters, fine devices, medium and light automatic machinery, especially strong on experimental work and originating of new machinery, will consider change; location immaterial. Box 928, AMERICAN MACHINIST.

OHIO

Mechanical artist, experienced in all classes machinery illustration, retouched photographs, wash drawings from the plans, etc., seeks position with engineering or manufacturing concern. Box 923, AMERICAN MACHINIST.

Screw machine foreman, now having charge of large automatic and hand machine department producing accurate interchangeable work, desires change; expert tool and cam designer, good executive and capable to handle department along the lines of modern cost and expense accounting; in present position seven years; location immaterial. Address "Foreman," Box 924, AMERICAN MACHINIST.

PENNSYLVANIA

Cost accountant, thoroughly experienced, desires to change; familiar with the various ways of handling overhead expense, piece work, premium and bonus systems and with cost estimating; only high-grade opening considered. Box 930, AMERICAN MACHINIST.

WISCONSIN

Situation wanted with company entering manufacture of automobiles or motors; capable of purchasing and installing machinery and tools, designing tools, jigs and fixtures, and as tool-room foreman; over ten years' practical experience; similar positions held before; at liberty October 1. Box 832, AM. M.

FOR SALE

For Sale—Screw manufacturing business; excellent opportunity and profits; reasonable price; first-class machinery. Box 913, AM. M.

Four thousand dollars will buy a light manufacturing machine shop, brass foundry and plating works, doing a safe, steady, profitable business in this city; established twenty years; health only reason for selling. For full information address Hoyt Investment Company, 4290 Queen Ave., South, Minneapolis, Minn.

For Sale—Three return tubular boilers, manufactured by Riter Bros., Buffalo, N. Y. Drums 72x16 feet 0 inches; each boiler with sixty-six 4-inch tubes; inspected by Travelers Indemnity Company, of Hartford, Conn; 93 lb. steam pressure; boilers in good condition; can be delivered in two to three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

For Sale—One Nash gas engine, 20 horsepower, two cylinder, for electric lighting, pumping or power; one Beaman & Smith horizontal boring mill; table 25 inches wide, 36 inches long; will bore 12 inches diameter, 24 inches long, and face 20 inches diameter; one 300 light J. B. Colt Co. acetylene gas apparatus. The above machines are in excellent condition, having been very little used. For further particulars and prices apply to Rider-Ericsson Engine Co., 35 Warren St., New York.

For Sale—Jobbing machine shop and foundry business, located in western New York; established over fifty years; has large and very profitable trade; 75 per cent. of the capital stock can be bought for $65,000; worth at least $100,000; fine equipment of tools and well organized working force; this is not a debt encumbered concern that needs financing; no extra capital required for operating, but a going concern that owners want to sell on account of other interests preventing personal attention. For further particulars address R. W. Gardner, 821 Railway Exchange Bldg., Chicago, Ill.

Talks With Our Readers

By the Sales Manager

No good paper is owned by its advertisers.

The readers hold title — free, clear, paid-up and no assessments beyond the subscription price.

There are certain classes of advertisers who seem to think that payment for space in the advertising pages entitles them to the use of the reading columns, and to dictate the policy of the paper, the color of the cover, the cut of the editors' clothes and the nature of their religion.

There are some publications weak-kneed enough to fall for this sort of dictatorial policy on the part of big advertisers, with the result that the paper loses its greatest asset—the confidence of its readers.

And with the loss of the readers' confidence goes the value of the paper to advertisers.

* * *

No useful engineering paper can be established and prosper long that is not published first, last and all the time for the reader, that is not helpful to him, honest with him, showing him how to better his work or his condition.

One that will take the side of a reader as against its best advertiser when the reader's interest is at stake.

And this is the principle upon which the AMERICAN MACHINIST is published—and we want you to know that such is a *principle* with us and not a "happen chance."

Your confidence is not to be trifled with, and the placing in the reading columns of manufacturers' cuts and fulsome praise of their output is trifling with you and belittling your intelligence.

Is it interesting and informative, is it new, and news?

That is the measure which must decide.

And the editors must be the judges and writers, and the paper must make and pay for the cuts.

* * *

The AMERICAN MACHINIST does these things, not because it likes to spend money, but because it knows that it is the best thing to do.

Every "house organ," every catalog, every circular holds a brief for the fellow who publishes it—and that is natural, and fair enough when the advertising is naked and not disguised in false whiskers and green goggles.

You accept the statements of manufacturers only after you have sifted and weighed their claims.

You look upon the editorial statements as authoritative because you know that the editors aim to make them such, and that they have the resources and knowledge necessary.

And so the good paper, the worthwhile paper, draws the sharp line between its reading and advertising pages and says,

"Thus far and no farther."

* * *

If this sounds like a reflection upon the advertising pages it is poor shooting.

We're proud of them.

We know that no technical paper carries a better lot of advertising, and none has better concerns represented.

We know that, as a rule, the advertising is interesting and informative.

We believe that most advertisers have grasped and applied the fundamental principle of profitable advertising—sincerity and truth.

We have confidence in our advertisers and want you to share it.

But advertising in this paper must be done in the name of advertising, and not try to sneak in at the back door.

Then you win—you know where you're at.

The advertisers win — they share your confidence.

The paper wins—its stand is recognized and appreciated.

And *that* is a treaty, close-knit, that carries no such word as failure in its lexicon.

* * *

Say you saw it in the American Machinist.

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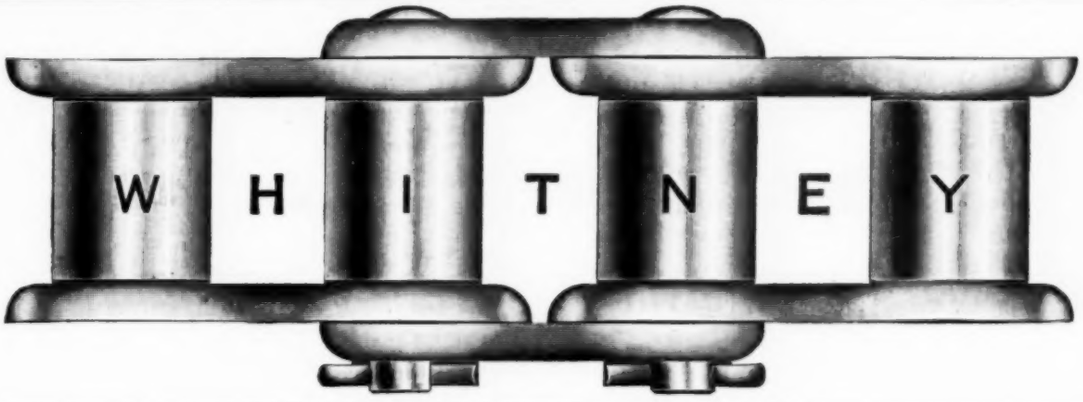
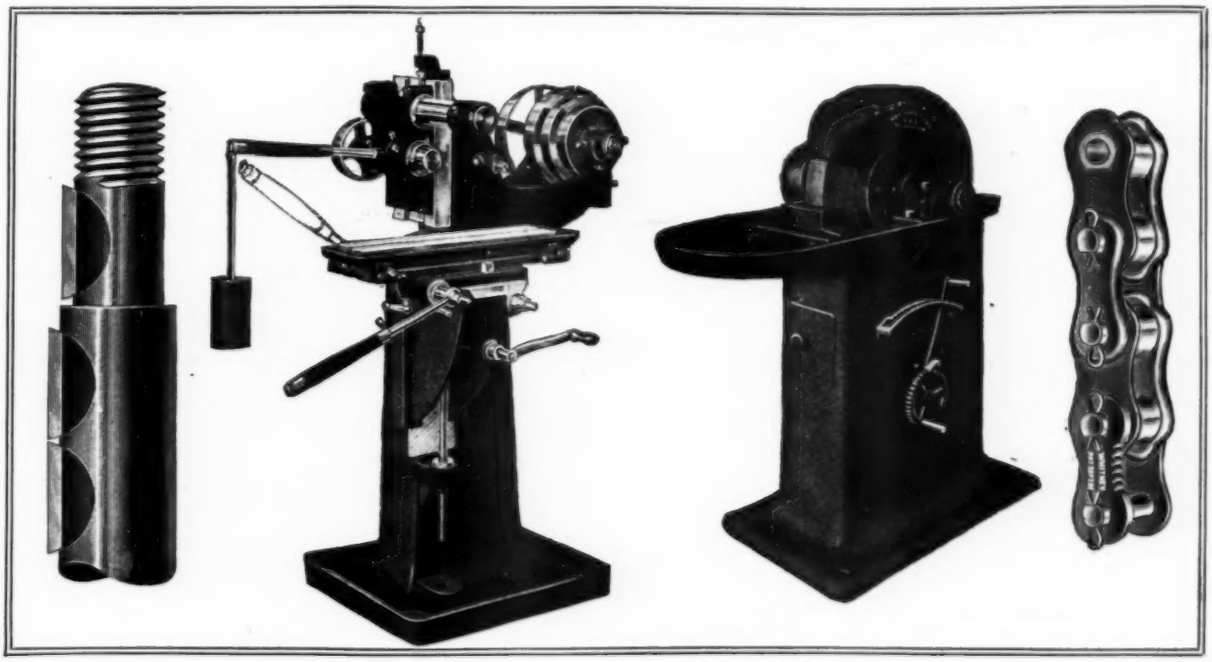


Chain Department

Roller Chains, Block Chains, Chain Belts, Quiet Chains, for Automobiles, Commercial Cars, Motorcycles, Bicycles, Machinery, etc.

Machine Department

Hand (feed) Milling Machines, 20-inch Water Tool Grinders, Keys and Cutters for the Woodruff Patent System of Keying, Presto Drill Chucks, Collets and Friction Tapping Devices.



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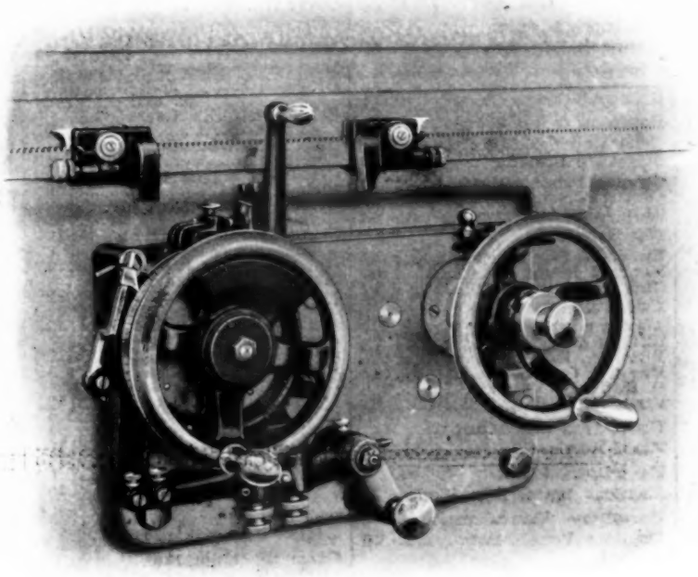
Drills, Pneumatic
Independent Pneumatic Tool Co. 80
Ingersoll-Rand Co. 81

Accuracy in the finished product is combined with economy in operation—both necessary features in a manufacturing machine.



B. & S. Plain Grinding Machines

are economical in operation because all of the working parts are compactly arranged and so can be manipulated easily and quickly. This feature is shown particularly in the cross feed mechanism and the back rest displayed in the cuts, where it can be easily seen that all adjustments are within easy reach of the operator.

The accuracy of the finished product is secured largely through the cross feed mechanism, which is of special design. After the adjustment has once been made the machine requires practically no care on the part of the operator and one man can run two machines.

To further increase the accuracy on long work of small diameter Universal Back Rests are furnished to support the work. These make it possible to grind shafts with a key seat, splined shafts and similar work. The back rests are universal in all their movements.

See our General Catalogue for full line of machines.

Brown & Sharpe Mfg. Co.,
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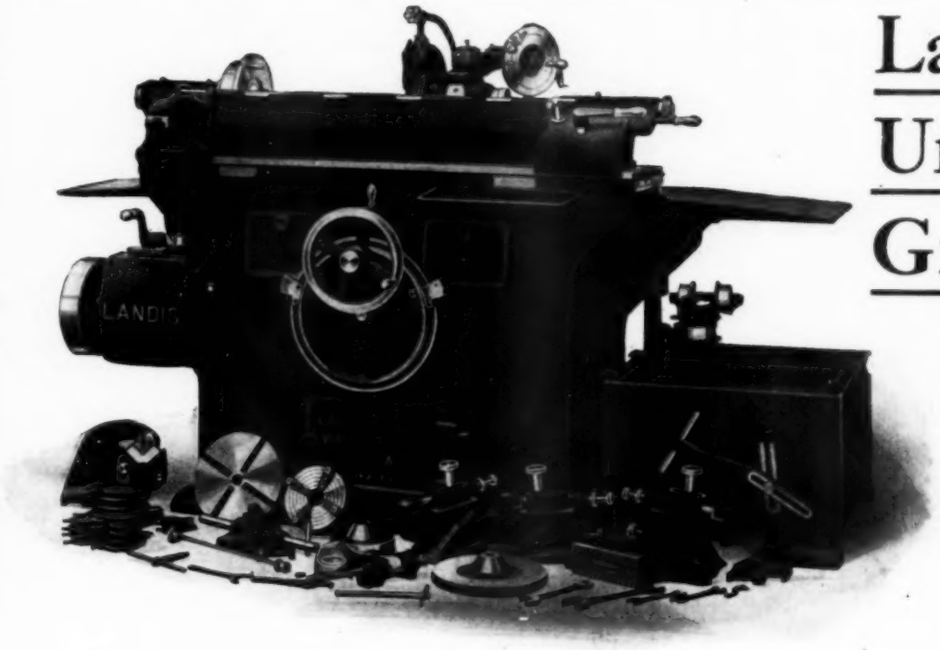

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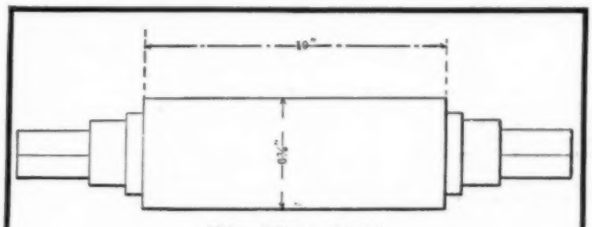

Tin Plate Roll
Grinding Time 10 Minutes

Material, Chilled Gray Iron
Stock Removed, .018" Diameter
Variation allowed, .001"

Note—Roll face only ground

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No. 119 D. Floating Reamers

These Reamers are made .003 undersize and are designed to be used in connection with Four-Groove Chucking Reamers and as a roughing reamer for Floating Expansion Reamers.

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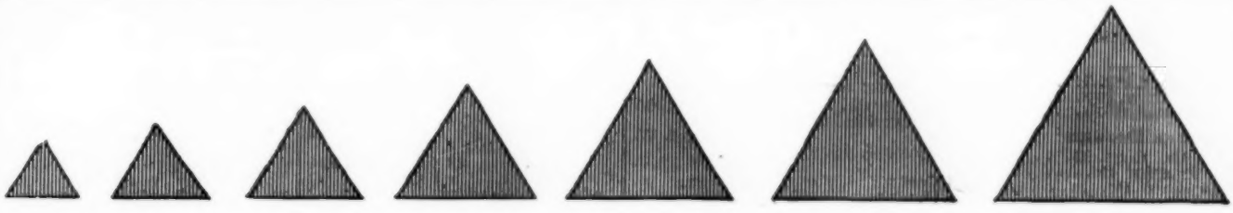

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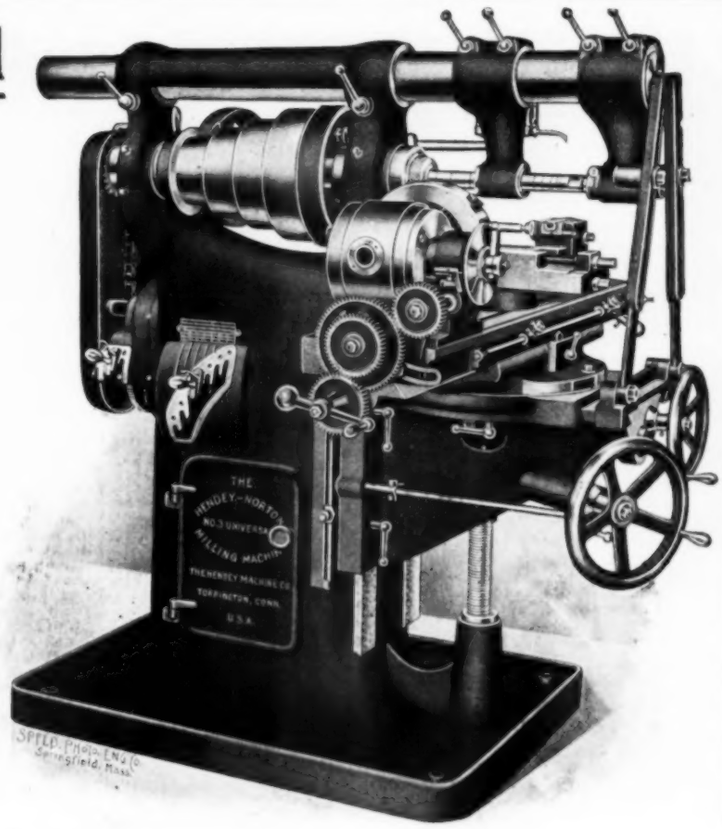

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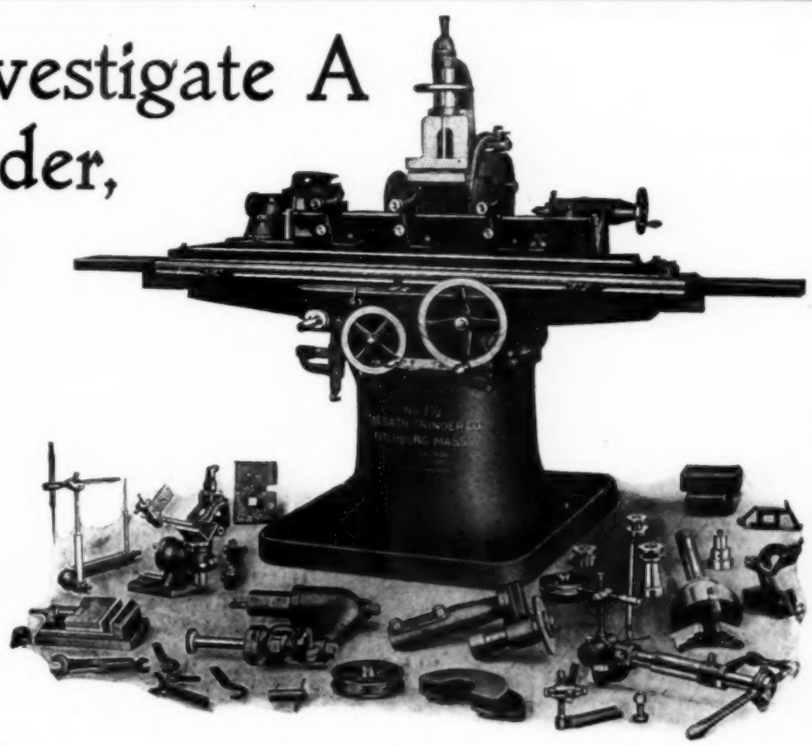

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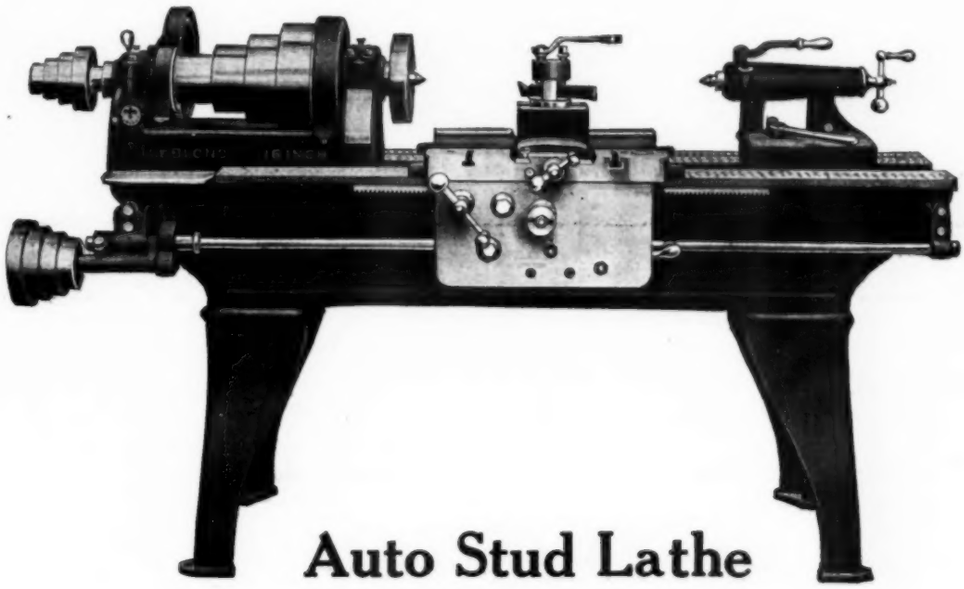

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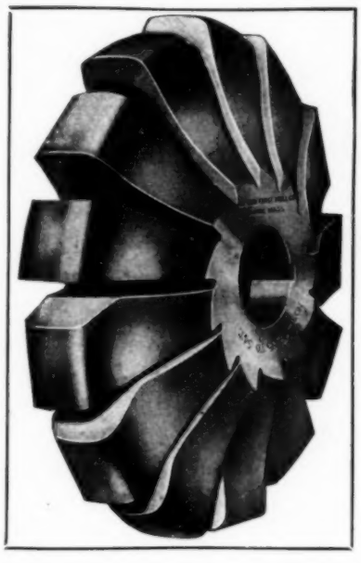

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